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TRANSLATION

MAN PENETRATES INTO THE COSMOS

By

M. G. Kroshkin

FOREIGN TECHNOLOGY DIVISION

AIR FORCE SYSTEMS COMMAND

WRIGHT-PATTERSON AIR FORCE BASE

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MAN PENETRATES INTO THE COSMOS

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Man Penetrates Into The Cosmos

By
M. G. Kroshkin, Cand. Phys-Math. Sci.

M. G. Kroshkin's pamphlet, "Man Penetrates Into The Cosmos", tells of manned space flights and about the use of rockets and artificial earth satellites for scientific purposes. The author tells of the basic stages in the history of the brief, but violently developing "Space Age": the works of the founder of astronautics, K. E. Tsiolkovskiy and the heroic flights of Soviet Pilot-Astronauts.

The author pays special attention to the description of the results of scientific investigations in space and points out their significance in the general complex of geophysical and astronomical sciences. With the aid of artificial satellites, man can look into the deep bowels of a planet, study the continuously moving air ocean of the earth and the influence of the sun on his life. Much attention is given to the description of the earth's radiation belts, their discovery and a hypothesis of their origination.

Data obtained in investigating the invesible part of the moon and interplanetary media is expounded. The question of whether or not there is life on other stellar worlds and can communication be established with intelligent beings of these worlds is considered. The scientific results of investigating outerspace near the earth and the moon by means of instruments and flying space stations and

ships are already impressive. The author attempts to look into the future and evaluate what the influence of man's entry into space would be on the progress of science and technology, culture and economics.

The pamphlet is intended for the general public.

Introduction

Man penetrates into the cosmos... Beginning in 1957 (International Geophysical Year) rockets and artificial satellites have been used for learning about the earth and the universe. If you considered the space age beginning with K. E. Tsiolkovskiy's theoretical works or the date of the launching of the first satellite, it is impossible not to realize that the history of this age is very short.

And how much was done during this period!

Our country surpassed all the other nations of the world and was the first to pave the way into space. The Soviet Union was the first to launch an intercontinental ballistic rocket, the first to send up an artificial earth satellite, created the first artificial solar satellite, the first to guide a space rocket to the moon, and to make a flight of an automatic station in the direction of the planet Venus. One after the other, Soviet satellite-ships with living beings on aboard, accomplished flights into space and returned to the earth. Flights of Soviet persons in space ships around the earth also contribute to our victories in the mastery of space. Citizens of the Union of Soviet Socialist Republics, Major Yu. A. Gagarin and Major G. S. Titov made the first flights into space in the world.

In these feats of the mastery of space are personified the genius of the Soviet people and the mighty force of leadership of the Communist Party. By the will of the working class and the will of the people, inspired by parties of communists, our country was converted into a powerful socialist state, and reached unprecedented heights in the development of science and technology. And now before the whole world, the working class, the Soviet collective-farm peasantry,

the Soviet intelligensia, the entire Soviet nation is demonstrating the unprecedented advances of science and technology. On the Soviet people, the builders of Communism, fell the honor of being the first to penetrate into the cosmos. The Soviet people place the victories in the mastery of space gladly in the service of all nations in the name of progress, happiness and peace on earth. The information obtained by Soviet scientists as a result of scientific investigations by means of satellites and rockets is already a contribution to the depository of knowledge concerning nature and is now being utilized in practical activities.

The entry into space, and the high level of the development of science and technology in the USSR show/ an immediate and active influence on the ultimate accumulation of knowledge and on the growth of the scientific and technical possibilities of the Soviet country.

Let us introduce some brief information concerning the development of rocketry.

The rocket in its simplest form has been known since ancient times. Rockets are able to carry a net load to a considerable distance and with a high speed.

Rockets appeared in Russia long ago. From reliable written information, the Russian rockets were the best, the most perfected. The "rocket institution", in which Peter I took part, developed the military signal rocket. The works of generals of the Russian Army A. D. Zasyadko (1779--1837) and K. I. Konstantinov (1818--1871) lead to the conclusion that beginning with twenty years of the 19th century, rockets became an effective weapon of the Russian Army. Only the development of rifled artillery in the end of the 19th century pushed the rocket into the background.

The period of "inactivity" of the rocket was the time of the origination of grandiose projects of applying the rocket for space flights. The birthplace of the new designation of the rocket is our country. Here is how it was.

...Spring 1881. An individual chamber of the Petropavlov Fortress. A student of the Peterburg Medical-Surgical Academy, Nikolay Ivanovich Kibal'chich,

persistantly ponders over drawings of some strange equipment. He hurries: he has only a few days of life remaining...

N. I. Kibel'chich -- talented researcher, who succeeded in making bombs by primative methods, which the members of the "Narodnaya Volya" (People's Freedom) killed Czar Aleksander II. N. I. Kibal'chich knows of his approaching death, but his mind is far away from it. And he writes not an appeal for a pardon, but of his ideas which he did not succeed to hit upon, did not succeed to accomplish. These ideas, which conquer death, concern overcoming the earth's gravity and the study of outer-space with the aid of rockets, and the utilization of reaction force for lifting a heavier-than-air apparatus. Having killed the thinker, the Czarist government buried his ideas also in the archives of the genderme administration. And only after the Great October Socialist Revolution was the revolutionist's scientific testament found.

In the provincial city of Kaluga on the border of the 19th and 20th centuries, a man with an original and penetrative mind search for ways of carrying out the age-old dream of people concerning flight to the stars. This was the modest physics teacher Konstantin Eduardovich Tsiolkovskiy. A man of exclusive efficiency and daring imagination, he developed various projects of conquering space, which have now taken on universal acknowledgement and merited fame.

The main theme in K. E. Tsiolkovskiy's works on astronautics is the utilization of a rocket for overcoming the earth's gravity and flight into outer-space. He proved that only rocket engines can operate and drive a flying craft outside the earth's atmosphere.

Tsiolkovskiy not only stated the correct idea, he theoretically established the possibility of interplanetary flights and developed the principles of constructing almost all of the more responsible elements of a space-ship. The great Russian scholar pointed out the expediency of using liquid rocket fuels, the necessity of cooling the firing chambers with one of the components of the fuel.

How can the greatest heat effect be obtained? In searching for the answer to this question K. E. Tsiolkovskiy subjected various components of fuels to theoretical examination and selected the most suitable ones. Gas rudders and a hinged installation of engines are applied in contemporary rockets for guiding their flight to the active portion of the trajectory, -- this was accomplished on the strength of Tsiolkovskiy's ideas.

Konstantin Eduardovich Tsiolkovskiy (1857--1935) -- a remarkable scholar and naturally-gifted person. He proved that rockets can overcome the earth's gravitation. K. E. Tsiolskiy gave the theoretical and principle technical development of the rocket. He was the first to comprehend the colossal signifance of the development of rocketry and man's entry into outer-space on the fate of mankind.

Indeed, there is not an assembly in the contemporary rocket as large as what Tsiolkovskiy thought there would be, as he strived to create a finished rocket design. But Tsiolkovskiy's greatest service was in the theoretical founding of the principle of reactive motion.

An incandescent gas, upon its escape from a jet, creates a reactive force. The higher the speed of gas escape, the greater the quantity of fuel we burn, the greater the speed attained after complete combustion of the rocket fuel. Tsiolkovskiy also obtained an accurate mathematical expression of this dependency for ideal conditions -- during flight outside the atmosphere and outside of the gravitational fields. It is now called the Tsiolkovskiy Formula.

The relation of the initial mass of a rocket to the final mass, established after fuel combustion, is a measure of constructive perfection of the rocket. It is obvious that this relation cannot be infinitely large, and, consequently, the final velocity of the rocket is limited. Calculations indicated that this velocity, even for a perfected rocket, is insufficient for flights to other planets.

In a rocket, which has obtained terminal velocity, tanks and the engine constitute a superfluous load. This means, that it is completely necessary to disperse the entire mass of the rocket up to final velocity. A rocket must be multistage. Each stage, having consumed its fuel supply, is separated from the remainder of the rocket and will not play the role of an unnecessary load.

This idea, in detail, to the number developed by K. E. Tsiolkovskiy, indicated solving in searching for a means of space flight. The development of rocketry received a strong scientific basis.

K. E. Tsiolkovskiy mentally traced the flight of space ships created with his calculations to other celestial bodies. They leave the earth and after a prolonged voyage, rearch the environs of another planet, which they must study... But is there a possibility of landing the entire space ship on this planet? The ship and fuel, designated for the return to earth, have a large weight. How can one imagine the energy to be spent in deceleration of the ship, in landing, and then once again to speed it up to cosmic velocity upon take-off from the planet? It is most expedient to place a ship into an orbit, surrounding the planet, and on its surface, land only a comparitively small rocket with everything necessary for investigations and return to orbit.

Just like from the surfsce of the earth, one can be launched at first to an artificial satellite (space rocket-port) and, having been loaded with everything necessary, set out on a distant space trip.

The economic advantages of such a means of flight into space are obvious,

because a requirement incomparably aries for precision of the work of the mechanisms and apparatus. One can note that Soviet scientists are striving for the complete realization of Tsiolkovskiy's ideas: does not the launching of a space ship to Venus with a heavy earth satellite really testify to this? And can there be any doubts that these and other ideas of Tsiolkovskiy concerning the mastery of space can be realized?

Not only the technical problems of his favorite idea concerning space flights excite K. E. Tsiolkovskiy. He says that these flights are needed for studying the space and other celestial bodies surrounding the earth. One of his basic works is called "An Investigation of Outer-Space with Reactive Instruments".

Tsiolkovskiy considered that a rocket infinitely expands man's "sphere of influence", opens access to the natural resources of other planets and the utilization of the colossal flows of energy, which the sun disperses into interplanetary space.

Only an insignificant portion of solar energy reaches the earth and is applied by man in hid economic activity. Why couldn't we use the remaining energy, when there is a means of sending rockets into space, even if it is only in our mind and on paper, but all capable of being realized.

K. E. Tsiolkovskiy solves various links in the problem of conquering space. He works out projects of orbital satellites (scientific and pre-landing stations), tries to find the most advantageous interplanetary routes. The scientist gives the answers of how to master the other planets and solve the problems of providing for the safety of future astronauts, seeks sources of food and oxygen for a long space flight and life in space.

Under these conditions, teaches Tsiolkovskiy, it is necessary to create an exclusive cycle of rotation of matter. This thought of Tsiolkovskiy's, as well as specific details of its realization, has now found universal recognition.

Thinking of ways of developing science after man's entry into space, K. E. Tsiolkovskiy proceeded from the comperitively modest level of knowledge concerning outer-space and the possibility of the existance of life there, which the people possessed at that time. One can agree or not agree with his individual proposals, but there is absolutely no doubt that the entry of man into space will have a decisive influence on the ultimate progress of the development of mankind. K. E. Tsiolkovskiy outlined the basic ways of conquering space, which must have been ultimately subjected to scrupulous verification with facts and figures.

The facts and figures were solid bases of all of K. E. Tsiolkovskiy's ideas and logical constructions. In the process of experiments, new facts and ways of carrying out the ultimate stages of investigation must have appeared. Therefore, the attempts of "visionaries" to canonnize Tsiolkovskiy's ideas were illogically presented, among them those which were based on simple proposals. Life is moving forward, and in order to keep in step with it, we must go on and develope K. E. Tsiolkovskiy's ideas!

The significance of K. E. Tsiolkovskiy's works is colossal. The modest teacher and self-taught person became an outstanding scientist. In pre-revolutionary Russia, K. E. Tsiolkovskiy was a lone dreamer with a reputation of being eccentric. Only a few advanced people of that time understood the significance of his works. In czarist Russia there were not any sufficiently qualified personnel and technical bases for accomplishing his projects for manufacturing space rockets. K. E. Tsiolkovskiy understood this and the realization of his dream was put off until the next century.

Only a revolution could change the position of things. And such a revolution, accomplished under the leadership of Lenin's Party with the hands of the working class and the peasants of the backward and illiterate Russia, was the Great October Socialist Revolution. It opened to the people the doord of schools and institutes, permitted the construction of a powerful industry, and created

all the prerequisites for the creative development of K. E. Tsiolkovskiy's ideas.

There were pupils and successors of Tsiolkovskiy. In the beginning they were enthusiatic, small groups of research workers. They later grew into large groups of qualified and talanted engineers.

V. I. Lenin attentively and carefully regarded the work of the first rocket enthusiasts. The Party and the Government pays much attention to the work of the groups of scientists, engineers and workers, who are creating contemporary rockets. The first liquid rockets in the world, tested in 1933, ram-jet engines and jet planes were the stages of a difficult struggle.

The Great Patriotic War interupted this. During those years, Soviet military rockets were created, which routed the German-Fascist invaders.

...A frosty evening. Silence changed to a cannonade, interlaced with a powerful, whistling rumble. It seems as if a thousand steam locomotives have suddenly started to let off steam. From the heights in the immediate rear, one hundred swift fiery shots break loose. They cut through the darkening sky, and after a few seconds, the hills before us completely blaze up with fires of the explosions. In a short time everything is wrapped up in smoke. The missiles of new volleys blaze up.

The shield of explosions ceases as suddenly as it began. Along the blackened, charred ground, breaking up the resistance of the remainder of the enemy, advances the tanks and infantry, liberating the Soviet land.

What participant of the Great Patriotic War is not familiar with this picture? Who did not hear those thundrous accords, which were brought into the battle symphony by the rocket devices, which the soldiers called by the affectionate name of "Katyusha"?

The swift and massed firing raids and the high maneuverability of the large combinations of this new arm guaranteed the success of many operations. In close interaction with the other arms, the rocket gunners paved the way to victory over

the enemy.

We know of the application of rockets in another theater of military operations during the Second World War. These were the German "A-4" liquid rockets, better known as the "V-2". They were launched from the Atlantic coast and brought down their attacks on London. It was impossible to intercept, or even detect an already lanched rocket, and the attempts to destroy them at the launching pads by means of aviation was not too effective, and the rockets created a well-known psychological effect with this bombardment. Of course, the use of these rockets did not have and could not have any influence on the progress of the military operations, and did not save Hitler's Germany from defeat in the war.

...The battles thundered. The scars on the explosion-riddled earth was covered with green. Millions of soldiers returned to peaceful life.

But what about the rocket shells? Their successors found themselves an honorable place in the world structure. The demolition explosion was changed into a research apperatus, the rockets became an indispensable means of investigating the upper atmosphere, of studying the sun, the earth's magnetic field, etc. With animals, they climbed to a great altitude, in order to pave the way into space for man by means of biological experiments. Rockets were applied for launching artificial satellites, automatic interplenetary stations and space ships.

12 April 1961 became a prominent day in the history of Soviet and world science, when the first manned flight in a satellite-ship was accomplished. A Soviet flyer, Major Yuriy Alekseyevich Gagarin, became the first Pilot-Astronaut in the world. The duration of the flight of "Vostok-1" was 108 minutes; the maximum altitude of the flight (in apogee) was 327 kilometers; the maximum weight lift (including the pilot-astronaut's weight) was 4725 kilograms. The launching site (Baykonur Space-Port) is located in an area 47 degrees north latitude and 65 degrees east longitude (Zapadnaya Sibir'), the landing site was in the vicinity of the village of Smelovka, the Ternovskiy Region, Saratov Oblast.

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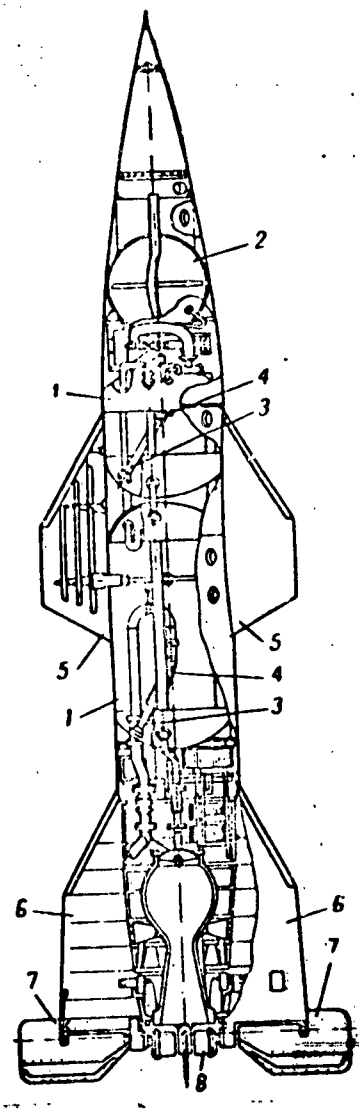
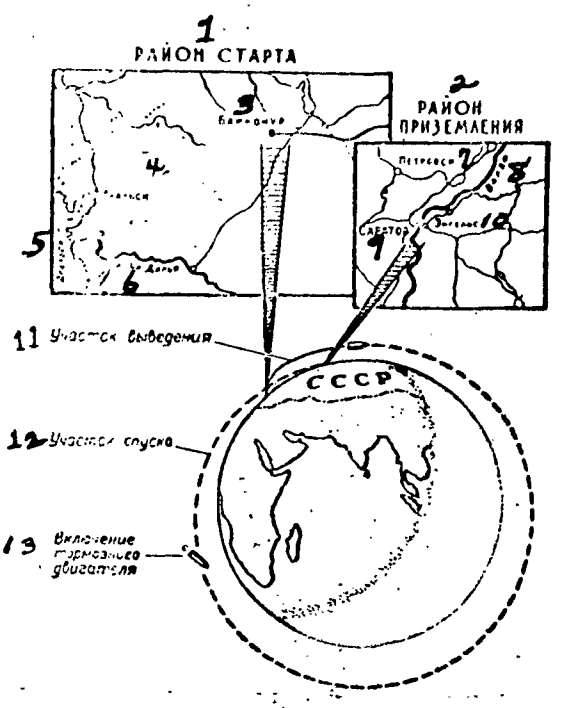


A contemporary liquid rocket--a complex technical device. In it many hundreds of large and small parts must operate with exclusive precision and reliability. The basic portion of the rocket is reserved for the fuel, which is placed in tanks (1) and is served by compressed gas, located in the "pressure accumulator" (2), along pipelines (3) and (4) or is transfered by powerful pumps into the combustion chamber, gradually cooled by one of its components. The burned products of combustion, running out with a tremendous speed from the nozzle of the engine, create jet propulsion. Guidance of the rocket in flight is attained by means of deviating the gas jets with special gas rudders (8) or a slight turn of the entire engine relative to the rocket. Air rudders (6), stabilizers (7) and wings (5) are placed only on rockets which are designated for flights into the dense layers of the atmosphere.

The rocket, which brought the "Vostok-1" into orbit around the earth, had six engines with a total power of 20,000,000 hp.

On 6 August 1961 at 9 am Moscow time, a new satellite-space ship, "Vostok-2", was launched into orbit, piloted by Pilot-Astronaut Major German Stepanovich Titov. He made more than 17 revolutions around the globe. After 25 hours and 18 minutes, G. S. Titov flew for more than 700 thousand kilometers. After completing the planned program, he landed in the territory of our land near the village of Krasnyy Kut, Saratov Oblast.

The flights of the piloted Soviet satellite-ships strengthened the leading role of our country in the development of astronautics, in uncovering the secrets of the universe.



KEY: 1. Launching area. 2. Landing area. 3. Baykonur. 4. Dral'sk. 5. Dral'sk Sea. 6. Syr-Dar'ya. 7. Petrovsk. 8. Volga. 9. Saratov. 10. Engels. 11. Entry portion. 12. Descent portion. 13. Deceleration.

CAPTION TO FIGURE ON PAGE 11.

The place of the historic launching and landing of "Vostok-1". The power of its six engines was 20 million hp. Such powers are necessary if we wish to send a large payload into space. The weight of "Vostok-1" was 4725 kg. The powerful rocket engines operate for several minutes but they consume a huge amount of fuel stored on the rocket in these minutes. But here is the satellite in orbit; it can "wind" its trajectory around the globe one revolution after another without consuming a single gram of fuel. And the length of each of these revolutions is almost 50,000 km! The rocket method of super-remote reports is the most favorable on the basis of fuel-consumption per kilometer of the route; it is the transportation of the future. The door to the future has now been opened by the historical flights of Yu. A. Gagarin and G. S. Titov.

K. E. Tsiolkovskiy pointed out the road to the stars and his students and successors made the initial stage of this path. It is symbolic that the first satellite was launched in 1957, the year of the 100th anniversary of K. E. Tsiolkovskiy's birthday. It was significantly earlier than Konstantin Eduardovich himself predicted. The labor the the Soviet people shortened the time. The rates of the mastery of space, which followed after the launching of the first satellite, permits us to consider that the cosmic future of mankind is not far away.

Soviet space research has a great scientific significance. The results obtained broadened our knowledge and permitted us to fill a number of gaps in various branches of science. Our relationship to the earth is also being changed. Scientists considered it as one of the planets, and greater attention is paid to those of its properties which are common to all the planets of the Solar System.

CHAPTER 1

THE MISSING LINKS

What is more important than the determination of the basic rules in the development of a planet and the elemental processes in nature? These questions can only be answered by obtaining an idea of all our knowledge of the universe. Very much was discovered by scientists even toward the fiftieth year of the 20th century, but very much lied within the limits of the possibilities of man. Neither man himself, nor the instruments created by him could abandon the planet, or rise above its surface higher than two or three tens of kilometers. This possibility appeared only after the development of sufficiently powerful rockets, and in particular, after the 1957 launching of an artificial earth satellite.

The structure of the earth, its composition at different depths, its evolution, the physical processes in the ocean and the atmosphere, the causes of magnetism and polar radiances, the motion of icebergs and the origination of seismic centers, meteors and solar radiation -- all of these questions stir the minds of people.

The future hides mysterious and exciting discoveries. Then, the history and basis of futher research will depend on what has already been done. What did the works give to science, which were accomplished in the slight, but eventful time from the day of the launching of the first satellite? What are the plans for further research?

In order to answer these questions one must know the present level of the development of science, where rockets and satellites are being used, the new possibilities of their development, which could not be obtained by just any means...

In our time it is difficult to speak of those things which are insufficient for the study of that or any phenomena. Which each new discovery, a whole series of new problems arises. Penetration into the depth of matter takes on the character of a chain reaction, the mode of which is sometimes very difficult to predict. At times, it is impossible to demand from an investigator, to accurately show, which of his results will be obtained tomorrow, which problems will arise after the completion of that or any investigation. It is enough to know the perspectives of the work, to know all the possibilities of a given method of research. Along these lines it is necessary to select the optimum and greatest perspectives, not relying on good luck, but bringing into the research the element of conscientious regulation.

For this, it is necessary to know which questions are the most actual, which links are missing in the common chain of the development of science.

The Earth. Man lives on the bottom of an air ocean. The striving for knowledge, for a more complete utilization of the earth's riches, compels him to investigate the earth. The epoch of great discoveries confirmed the guesses of the ancient thinkers, that the earth is not the center of the universe, and destroyed the religious conceptions. With the disappearance of the successive blank spaces, with the description of all parts of the globe, it seemed that man knew just about everything about the earth. Is that so?

It would be more correct to answer that man knew nothing besides the earth's

surface. What is the structure of the deep regions of the earth's core, the origination of the earth, its growth and shape? What is the cause of the earth's magnetism? All these and many other questions remained unanswered. Various guesses were discussed, more or less fundamental hypotheses. Specific positions, which often contradicted each other were established by witty methods and complex calculations.

One claimed that the earth and other planets were formed as a result of the cooling of a burning mass, ejected from the sun. No, the earth was formed from the accumulations of interplanetary material and gas and in the process of forming, conversely, was heated up, said others. At the present time it is more valid and probable to consider a second hypothesis. But reliable, comprehensive proof of the truth of that or any hypothesis is absent. It can be obtained only after a study of the other planets and quite sufficiently, if one wants to successfully observe the process of formation of any planets from the stars... The role of rockets in the solution of this problem is clear.

The question of the age of the earth is one of the most conclusive at the present time. With the discovery of radioactive decay it was possible to determine quite reliably the age of any rocks. Actually, if the mode of the reaction and its speed is known, if the quantity of the decay products is determined, then we can learn the time in which this reaction transpired, we can compute the age of a rock. Series of such investigations offer approximately similar orders of values, therefore there is a basis to consider that the age of the earth is about 3 to 5 million years old. The age of meteorites determined on the basis of lead content, of the final product of radioactive decay, coincides with the age of the earth on the order of size.

But where do the rockets and satellites come in?

For determining the age of the earth, ofcourse, they provide nothing, but wi-

thout them it is impossibile to solve the problem concerning the age of other planets, and this will be important material for a judgement concerning the origin of the entire planetary system.

Up to the beginning of the investigations with the aid of satellites it was already known that the earth is an irregular sphere. Even before the launching of the satellites they began to discuss the possible methods of determining the shape of the earth with their help.

What kind of internal structure does the earth have? How are the masses in the earth's depths distributed? Gravimetric surveying, a method of accelerating the earth's attraction of gravity in verious points of the earth, provides information on the size of the force of gravity on the surface of the earth. But it does not provide information concerning the sources of anomalies[1] of gravitation, their size and depth of bedding. Upon the solution of this problem one equation with two unknowns is obtained. In order to solve it, it is necessary to have data on the anomalies of gravitation at quite a significant distance from the earth. Artificial satellites can aid in the solution of this complex and important problem.

The magnetic field of the earth... We have heard everything concerning its existence and wonderful properties of magnetic pointing. Seamen and travelers know, in addition, that there are magnetic anomalies. But ask them: how did the existance of the magnetic field originate and how about the appearance of anomalies? They do not answer. They cannot answer this with complete confidence. Not even the scientists. The explanations which are made are usually more or less probable hypotheses. The most significant of them explains the origin of the magnetic field by the presence of powerful annular currents in the nucleus of the earth. This

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1 Anomaly -- a deviation from the normal, predictable theory of the change in any size.

hypothesis explains the proximity of magnetic and geographic belts. Rockets can help in the investigation of the magnetic fields of other celestial bodies and also explain the reasons causing magnetism of the planets.

The utilization of satellites for studying large anomalies of a magnetic field has important significance (similar to the investigation of the distribution of masses in the earth's core). Knowledge of the vertical gradient[2] of a magnetic anomaly is a sufficient basis for a judgement concerning the depth of bedding of sources and its causes. This data, obviously, cannot be obtained by any other methods.

The formation of a magnetic field, caused by currents in the ionosphere, may be investigated only by studying the magnetic and ionospheric problems of the upper atmosphere.

Artificial earth satellites are excellent earth surveyors. It is known that in the ocean it is impossible to conduct a trigonometric survey, and a ship's determination of coordinates on the basis of celestial bodies offers an essential error, which now does not suit the geodesists. The determination of the position of a satellite in any moment of time . . from any point gives its coordinates in ratio to another, quite distant point, if we know the position of a given revolution of the orbit in ratio to this other point.

Of course, the enumerated problems do not exhaust the possible application of rockets and artificial satellites for studying the physics of the earth. In the process of perfecting an apparatus which enlarges the accuracy of observing satellites, their duties will increase. It is important that this apparatus, it would seem, be an exclusively cosmic medium of investigation which would prove to be indispensible also for studying the bowels and evolution of our planet.

The Air Ocean. Hurricanes, rains, snow-storms, thunder-storms and disasterous

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2 Gradient -- degree of change in the space of any size at a shift to a unit of length.

draughts -- who knows these phenomena of atmospheric processes, the life of the air ocean! Sun-scorched deserts, sudden devastating floods, storms -- all these phenomena of nature strongly influence the life and economic activity of man.

Not long ago, man was a blind plaything in the hands of the elements, people turned to a non-existant god for the purpose of bringing about or, conversely, stopping rain. And not very long ago, airplanes stood idle at the airport for weeks because of non-flying weather.

And now man, in spite of individual possibilities of active interferences, is still not able to change the weather at his own discretion. But airplanes still do not stand idle at airports. And this is not only due to new means of radio navigation, but also possibilities of making flying weather under determined conditions. Scattering winter clouds to an area of one hundred square kilometers, "opening the sky above the airport" -- this is now not wonderful, but fully a real thing.

Ten astronomers assembled on 15 February 1961 in Krym, in order to observe a total solar eclipse, but the sky seemed to be covered by solid cloudiness. Several years ago the situation would have been hopeless, but this time everything was obtained anyway. Airplanes rose into the air, and as if by magic of a wand, the cloudiness began to thin out and dwindle and the sky became clear. The astronomers conducted the observations. In this way, the scientists broke into the natural mode of events and changed it in relation to their own practical needs.

Of course, it is not necessary to change the weather to one's own satisfaction for all cases of life. Very often it is enough to simply know it for a certain time in advance, and to have a weather forecast. Then it is possible to be prepared for any weather, and to take necessary measures or simply change work plans. Knowing of an arid summer, one can eliminate snow and construct a graph of the movement of transportation in roadless regions depending on the expected weather etc.

But a weather forecast is not always accurate. Isn't it really so? You wait impatiently for a vacation, to spend it outside of the city. The weather report, given the day before on the radio, strengthens your hope for a good rest. But a few hours do not even pass as the sky becomes overcast, it starts pouring rain, and you change into dry clothes or wait for hours for the rain to end in some sort of shelter, cursing those who deceived you.

Did they actually deceive you?

Of course not. It is not a subject for jokes and even more for deliberate deception. Maybe, the meteorologists made an error or could not calculate accurately or quickly enough the change in temperature, pressure and humidity? No, also. Competent experimental people are occupied with this business and rapid electronic machines and improved computation methods are in their service. Who is guilty? Mistakes in forecasts originate from the incompleteness of our knowledge of the physical processes in the atmosphere and the insuficiency of the original data for calculations.

What is needed for an estimation of the possibility of an active effect of forecasting on the climate and weather? It is necessary to know the laws of atmospheric motions, their "mechanism" and "springs", setting it into action, guided by motions of the atmosphere.

Man can immediately sense a change in the temperature of the air and its motion. Therefore, it is essential that a study of the atmosphere begens with tests to establish the laws of temperature fluctuations and explain the tendency of prevailing winds on the surface of the earth. From the experience of climbs into mountains and observation of permanent ice on mountain peaks, the decrease in air temperature with the increase in altitude was made known to man. The movement of high clouds told of the presence and possible wind changes at great altitudes.

The development of physics led to the necessity of studying the atmosphere.

The change in air pressure before then was interpreted only as mountain sickness or subconcious sensations. The humidity of the air was observed in its obvious phenomena -- clouds and fogs. It was necessary to investigate the composition of the atmosphere, its electricity and dust content, the various types of movements and flows of energy brought about by the atmosphere, etc.

Right now on the surface of the land, many thousands of meteorological stations are conducting regular observations of the changes in the atmosphere. Does this mean that a meteorological network can provide us with all the necessary data for studying the atmosphere?

No, the data obtained at the bottom of the air ocean is not enough, even if it were more complete. It is necessary to know, in addition, the structure and the laws of motion of every thickness of the atmosphere. Man was able to obtain the first reports on the structure of the lower layers of the atmosphere after the invention of flying crafts: balloons and air planes. Later, to study the atmosphere, pilot-balloons and autometic devices (radio sounds transmitted data by radio on the temperature, humidity and pressure of the atmosphere at various altitudes, right up to 20--30 km) were widely applied.

It was established that the temperature of the atmosphere with an increase in altitude continuously decreased to a certain limit -- tropopauses found at an altitude of 8--18 km (depending on the season and geographical latitude of the place), but higher the temperature maintains an approximately constant value. In the lower layer, the troposphere, it is more than three fourths of all the air and almost all water vapor. In the troposphere clouds develope, and it rains and snows. The upper layer, the stratosphere, was considered to be a comparitively immobile layer.

Such a representation proved to be short-lived. In spite of the clarity of the difference between the troposphere and the stratosphere, strong air currents and oddities in the propagation of a sound wave from strong explosions were also discovered. The waves were heard well near the place of explosion, because there

was a certain "zone of silence" and again due to a zone of sound audability. A theory explained the nature of this phenomenom. A singular cause of it could have been an increase in temperature of the atmosphere at great altitudes. Ground observations permitted another explanation of the nature of this heating: the intensive absorbtion of the ultraviolet portion of solar radiation by the ozone layer, loceted in the stratosphere.

The study of the changes in the characteristics of the stratosphere depending on the geographical latitude, season and time of day becomes very significant for investigating the influence of its heat and dynamic conditions on the lower layers and knowledge of the processes taking place in it. An effective means of probing the stratosphere up to its higher layers was needed...

The routes of air ships are going higher into the atmosphere. Right now airplanes are reaching altitudes of nearly 34 km. The time is coming when rocket-planes will attain altitudes of many tens of kilometers. For designing such planes, the selection of new airways is necessary to know the direction and velocity of the air currents in the middle and upper layers of the stratosphere...

The atmosphere of the Earth is its protective shell. As a thick armor, the air shell protects the planet from myriads of small and large meteor particles. Falling into the atmosphere, they burn up. And only the larger meteor bodies reach the surface of the earth. The Earth's atmosphere does not let the short-wave, ionizing radiation of the Sun and cosmic radiation to pass through it. For man to enter the stratosphere and the upper layers of the atmosphere it is necessary to know the degree of enlargement of meteor and radiation danger...

The development of radio engineering led to the discovery of an amazing phenomenom. Radiowaves of the shortwave band are propagated rectilinearly and restrict radio communications only to the limits of direct visibility. But at some distance from the transmission point they, again as if reflected from some layer, are returned to the Earth. It was assumed that the reflecting layer consists of an ionized,

current-conducting gas. The reflection of radiowaves permitted a computation of the altitude of this layer. It was approximately 80--100 km.

The change to higher frequencies led to the fact that radio beams stopped reflecting from this conducting layer, penetrated through it, but were reflected from another layer, located even higher. In this manner several ionized layers were discovered. One of them, layer F_2, was located at an altitude of approximately 300 km.

These ionized layers were called the ionosphere. An opinion was expressed that the ionosphere in its formation is caused by shortwave, ultraviolet solar radiation or continuous intrusion into the atmosphere of a vast number of crushed solid particles (micrometeors moving at tremendous speeds). The study of the ionosphere by radio-sounding of reflected radio-signals of various frequencies permitted the establishment of the variability in the position of the layers according to altitude and in the concentration of electrons in it. An irregularity of the concentration was detected in the horizontal direction, the presence of gigantic ionospheric clouds and an irregularity in the variation of the composition of the ionosphere with time. All this could not explain one of the hypotheses of the formation of the ionosphere.

Radio-sounding does not obtain information on the structure of the ionosphere higher than layer F_2. It is true that an intelligent method of studying this area of the ionosphere was proposed on the basis of "whistler atmospherics", i.e. on the basis of the whistle assumed sometimes by the radio-receiver and characterized by lightening flashes in another hemisphere of the Earth.

These radio-signals are distributed along a magnetic power line, and their sprectrum of frequencies is transformed (changed) depending on the concentration of ions along the way. In as much as the way was known (the discharge is always on the other end of the power line, where the receiver is), then a study of this signal transformation provided some bases for a judgement on the total concentration

of ions along the power line, among them, those higher than layer F_2. Of course, the judgement was too rough because the accuracy of the method could not have been high and, besides, it provided only certain average values at large arc lengths. Here we were forced to turn to science when direct methods of investigation were not proposed.

Considering all this, and also the significance which the ionosphere acquired in radio-communication in the shortwave band, the scientists faced the task of studying it in more detail. But for this they needed a means of investigating more immediately, more effectively, than radio-sounding...

The firey lines of meteors burning in the atmosphere on a dark night sky are familiar to everyone. But few people thought that meteors could help the scientists in some way.

It was established, by ground investigations, that meteors are divided into two groups: sporadic meteors irregularly penetrating space, and meteor streams (fragments of decomposition of comets). By studying the spectra of meteors, it was established that there is calcium, nickel, iron, magnesium, manganese, chromium and sodium in their composition. The meteorites which fall to the Earth are iron and rock. The velocities of the meteorites relative to the Earth are 11--73 km/sec. Ground investigations indicated that, evidently, a large portion of meteoritic matter has a porous, loose structure, and its density is approximately 1/20 g/cm^3.

There is an assumption that streams of meteor dust (pulverized loose particles in structure) penetrate into the atmosphere with a very small "cross load" (ratio of mass to a characterized area, for example, cross section areas). The velocity of meteor dust is not enough to lead to combustion in the atmosphere, but enough for ionization. If this is so, then the intrusion of meteor dust could explain certain features of structure and the existance of the ionosphere, for example "residual ionization", observed at night, and various formations of a "sporadic layer" E.

In such a manner, meteors are "suspected" in the formation of the ionosphere. A supposition ("Bowen's hypothesis") expresses the fact that meteor "rains" have immediate connection with ordinary rains. This strange and almost mystical connection at first glance is simply explained: condensation of moisture is possible on cosmic dust -- micrometeors, smoothly settling in the atmosphere, and on solid products of combustion of meteors in the atmosphere. For the formation of precipitants of a sufficiently high air moisture, dust particles of the nucleus of the condensation are required.

These suppositions require much more complete information concerning meteor streams, dimensions and energy of micrometeors. For an investigation of meteors in the day-time (at night they can be seen visually and photographically) radar observations can be conducted and their ionized traces can be detected. Reliable data concerning the sizes and energy of meteor particles might be obtained only as a result of leaving the limits of layers of the atmosphere, the density of which leads to combustion of the meteor particles.

Radar observations of meteor trails led to the discovery of their drift, displaced with the motion of the upper atmosphere. It seemed that in the upper atmosphere there was motion at high speeds. It was necessary to create methods for their immediate study and continue investigations of the density, temperature, chemical and ionnic composition of the upper atmosphere...

The utilization of rockets and artificial satellites was not worked out by an immediate study of the upper atmosphere in a given point. Leaving the limits of the atmosphere, we were permitted to see nebular systems (or their large portions), observe their structure, evolution and motion. If the dynamic influence of the processes in the upper layers of the atmosphere on the troposphere for many meteorologists is doubtful, then the detection of nebulous masses has an immediate and exclusive meaning for meteorology.

Source of energy. The Sun is the source of energy of winds and sea currents, transfer of a colossal quantity of moisture, the cause of decomposition of rocks and formation of soil and a source of life on Earth. This gigantic natural thermonuclear reactor sends flows of radiant energy into space. A slight portion of it, falling on the Earth, is enough to maintain a comparitively high temperature of the ground, water and atmosphere. Heating of seas and dry land leads to the evaporation of water from their surface. Irregularity of heating leads to atmospheric motions and precipitation. Can we assume that the Sun provides energy to all atmospheric processes and controls them?

For such assertions there is still no serious foundation, besides certain statistical dependencies. In the explanation of atmospheric processes the investigators were divided into two unequal camps. The majority considers that all atmospheric phenomena are mainly internal processes in the atmosphere. They develope independently from small changes in the intensity of a gradual flow of solar energy.

Let us visualize the oscillations of pendulums which change their dimensions and weight. The possibility of the existance of such oscillations is stipulated by the presence of Earth's gravitation. The law of oscillation of a pendulum is determined by the variation of the natural characteristics depending on other motions. It can be assumed that atmospheric motions are similar to such a complex mechanical system with coupled elementary motions.

Other investigators maintain that the atmospheric processes must obediently follow all pulsations of the flow of solar energy, the activity of the Sun exactly the same as a magnetic arrow follows a magnetic field and its variation.

Who is right?

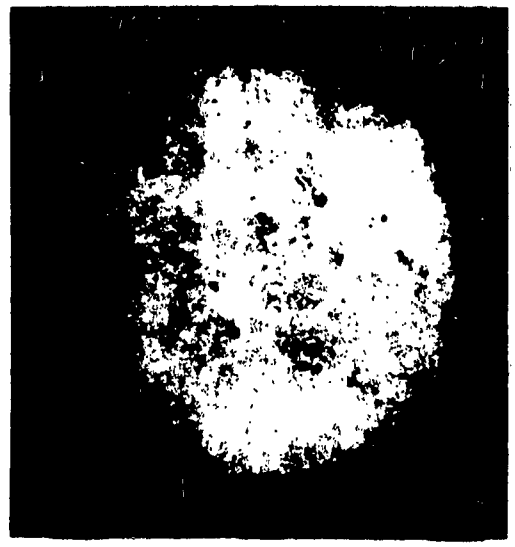
The Sun is very stable as a source of energy. The total flow of radiation emitted by it can undergo complete changes in several percentages. It is impossible to speak of any control, since the activity of the Sun practically does not change, the supporters of the first trend proved.

The constancy of solar radiation is characteristic only for the visible, long-wave part of the spectrum, on which a large portion of energy emitted by the Sun falls. Short-wave (ultraviolet and X-ray) radiation, and also corpuscular radiation sharphly change in time. On them falls a comparatively slight portion of the total energy emitted by the Sun. In contrast to the radiation in the visible part of the spectrum, they are completely absorbed by the atmosphere, which causes various photochemical reactions, and heat it. Consequently, they determine that motion in the upper atmosphere, which can be transmitted by the lower layer. The supporters of the other trend asserted in that manner and confirmed it with a comparison of the period of changes of various hydrometeorological and biological phenomena with solar activity.

When there are no comprehensive proofs, one can argue for ever. The judges in this arguement must be the experiment, which could help the scientists to establish not only an actual and complete picture of atmospheric motions at all altitudes and their mutual connection, but also the energetics of these motions. For this we must study the shortwave part of solar radiation, the mechanism of its absorbtion by the atmosphere. We can say the same about the corpuscular radiation of the Sun. At the same time with the atmosphere on the same horizons it was necessary to study solar radiation. For this it was necessary to provide a corresponding apparatus at an altitude tens and hundreds of kilometers from the surface of the Earth...

Above, we spoke of the role which the shortwave radiation of the Sun plays in the formation of the ionosphere. A study of this radiation could help in the solution of problems connected with the origination and existance of ionospheric layers.

The aurora polaris, known by the inhabitents of the north, was explained a long time ago by the penetration of corpuscular currents, ejected by the Sun into the upper layers of the polar atmosphere. For a detailed study of these currents



Photograph of the Sun. The sun is a giant firey element. As a result of the self-regulating thermo-nuclear processes on the sun a gigantic amount of energy is liberated. Solar energy is the source of the existance of life on the earth. It guides the air and water masses of our planet into motion. The solar energy falling on the earth is only an insignificant part of the total energy radiated by light in world space. The main portion of solar energy occurs as visible radiation. It practically does not change in time. The shortwave--ultraviolet and X-ray--radiation of the sun is changeable. They depend on solar activity. The amount and area of the blank spaces on the sun is a characteristic of the activity.

of charged particles, it was necessary to furnish instruments to the areas of the aurora polaris...

Cosmic radiation. The radiation of the Sun, stars, nebulae... It must seem that this is the entire list of possible radiations. It was proved that this is not so...

Several decades ago, we succeeded in registering charged particles of large energies, the passage of which could not be explained by the radiation of any specific star or galaxy. They pierce space in all directions, cut into the atmosphere with speeds close to the speed of light and, colliding with molecules of air, are broken up into nuclear particles. Among the nuclear particles there are those which easily penetrate through large thicknesses of matter. These are somewhat secondary cosmic particles and are registered on the surface of the Earth, under water and even in deep mines.

Back in 1927 particles of cosmic radiation with energy up to a million million electronovolts[1] were discovered. For an estimation of this amount we can note that the energy of molecule of air at ordinary temperature is by far less than one electronovolt. The maximum energy, given off by the charged particles in contemporary accelerators of charged particles, is calculated as ten millions of electronovolts (30 million electronovolts).

What is the source of this radiation? What is its role in the atmospheric processes? Which nuclear particles are formed after collision with air molecules? What is the intensity of this radiation and its influence on living organisms which will go out of the limits of the atmosphere or if only its lower layers?

It is impossible to answer all these questions without studying primary cosmic radiation, i.e. cosmic particles in their "primitive" form. Launchings of balloons to altitudes of 30 km provided determined results, but excluded the possibility

1 Electronovolt -- the energy an electron acquires accelerating into an electrical field with a difference of potentials by 1 volt.

of studying primary cosmic rays, and did not permit a sufficiently complete development of all trends of the investigations of cosmic radiation. Rockets and artificial satellites must have become tools in the hands of physicists and astronomers studying this mysterious phenomenon of nature...

Only these artificial celestial bodies created by man, patroling the near-by environs of the planet, could investigate all the power flow if not its sources, then at least on the borders of intrusion into the atmosphere and on the routes of penetration into its width.

Spectral investigations of the Sun. In a number of problems of this portion of the investigations there also existed an astrophysical one -- a study of the Sun itself. Of course, here we do not bear in mind the sending of instruments to the Sun: they would simply vaporize, having approached it.

The processes on the Sun can be studied now by widely diversified spectrometric methods, by means of investigating the spectrum of radiation of the Sun. In this manner we could determine, for example, the composition, temperature, magnetic field and velocity of the motion of radiation gas. But maybe all this would to simplier to continue studying the customary ground conditions, as has been done at the present time?

It seems that the astronomers are satisfied by this "for lack of anything better". The atmosphere (it is absolutely transparent at the first glance of the medium) is exclusively a dense light-filter passing electromagnetic emissions (which light is directed to) only in two comparatively narrow "windows". The first of them passes rays of the visible part of the spectrum with a length of the wave from 0.3 to 0.75 microns. The second "window" is significantly wider. This radio-emission has a wave length from 1.25 centimeters to 30 meters. The remaining areas of electromagnetic emissions of the Sun and other celestial bodies are inaccessible for observation from the Earth.

Leaving the limits of the atmosphere is an imperative condition in the development of astronomy.

Neighbors of the Earth. Man's dream was to fly to other celestial bodies, in the first instance to the Moon, Mars and Venus. He wanted to find on them if not brothers in intelligence or life in some sort of form, then, at least, more or less favorable physical conditions for man to visit them. This natural desire led to the verge of contradictory judgements concerning other celestial bodies. Wishful thinking was reflected in the treatment in these or any of the experimental data.

Remember the innumerable "science-fiction" novels which proposed that the Tunguss Meteorite was a Martian ship. Remember the discussions concerning the presence of an atmosphere and life on that side of the Moon which is always hidden from people's glances. Remember the "canals" on Mars, the Schiaparelli discoveries, and the mysterious "radio signals from Mars", which were accepted for twenty years and served as the subject of A. Tolstoy's "Aelita".

The possibility of collating the scientific data and fantasy impels us to carefully relate it to any circumstantial or sufficiently authentic information concerning these celestial bodies. There is still little accurate, verified data on the celestial bodies.

Almost every question linked with the investigation of the close neighbors of the Earth leads now to the utilization of rockets and artificial satellites. Too little is known on the neighboring planets. Other possibilities of obtaining sufficiently complete scientific information are practically absent, besides the direct sending of instruments to these celestial bodies and the hope that man in time can investigate them himself.

The gaps in the knowledge of the cosmic neighbors of the Earth are great. It is very difficult to list those missing links in their investigation which could be filled in by means of the application of research rockets. This is an entire "blank space". For direct investigations here is the whole "missing link", with

the exception of those stingy data which is now at man's disposal...

Mars is located at a distance from the Sun 1.52 times greater than the Earth. It is better studied than any other planet. The transparent, rarefied atmosphere of Mars creates favorable possibilities for observing its surface. The mass of Mars is approximately ten times less than the mass of the Earth. This namely is explained by the great rarefaction of the atmosphere of Mars at the surface and its expense in interplanetary space.

The period of revolution of Mars around its axis (24 hours, 37.4 minutes) is close to the Earth's exactly the same as the inclination of the plane of the equator towards the orbital plane. Therefore, on Mars the seasons change and the length of the days is similar to the Earth's. Due to its great distance from the Sun, Mars obtains significantly less radiant energy than the Earth, and the temperature on the surface of Mars is substantially lower.

Approximately twice as much carbon dioxide is found in the atmosphere of Mars, than the Earth has in its atmosphere. Scientists consider that the free oxygen there is by far less than in the terrestrial air.

What are the sources of the appearance of oxygen in the atmospheres of the planets? Some scientists express the supposition concerning the possibility of the dissociation of water vapors under the influence of solar radiation. From here it follows that the lower temperatures of the surface, making the evaporation from it more difficult, and also the lower temperatures of the Martian atmosphere led to a decrease in the content of water vapors in it on the tropopause level. All this inhibits the formation of free oxygen by means of dissociation under the action of the shortwave radiation of the Sun. The result of spectral measurements of the lines of molecular oxygen provides a basis to assume that the content of oxygen in the atmosphere of Mars is almost a thousand times lower than in the Earth's atmosphere. This corresponds to the above introduced supposition. Observation of the polar caps changing during one year, evidently, indicates that water on Mars

exists in the form of ice or frost in the polar regions.

Photograph of Mars. Mars is one of the closest neighbors of the Earth. Differing from Venus which is constantly covered by clouds, Mars has various white polar caps, dark spaces (according to some assumptions, these are areas covered with vegetation), and the so-called "canals". Several scientific and fantastical assumptions are connected with this planet. This photograph was taken through the terrestial atmosphere with the aid of a telescope. The day will arrive when "intelligent" interplanetary stations will provide us with clearer, more detailed photographs of this and other planets, and also data on the atmospheres, their structure, physical conditions on them and the possibilities of life

The basis of the Martian atmosphere is probably nitrogen. Argon must be a product of the radioactive decay of potassium. There are strong winds in the atmosphere of Mars, which are confirmed by the observable sand storms.

Three eights of the surface of Mars is taken up by dark spaces. Investigators conditionally named them seas. The structure of the spaces and the seasonal changes of their colors (with the approach of Spring they become darker) offer the pos-

sibility to suppose that these spaces are areas of vegetation. The remaining part of the surface of Mars is a reddish-yellow color, evidently a desert.

Not long ago, a curious, although insufficiently founded hypothesis was expressed concerning the structure of the crust of Mars. It originates from the fact that on Mars the relative content of light elements must be greater than on the Earth due to the significant remoteness of Mars from the Sun. The relative (percentage) content of water on Mars is greater than on Earth. This water is permafrost which covers the surface of the Martian oceans. The surface of this ice is covered with fragments of decomposed rocks which compose the peculiar soil of the planet.

If this is so, then during the Martian summer only a comparatively thin layer of soil has time to defrost, creating conditions for the growth of plants. Of course, this favorableness is relative, and even in the equatorial belt it, obviously, must correspond sooner to the polar, than the temperate zones of the Earth.

Are there animals or highly-organized forms of life on Mars? This is, at least, debatable. There is much more basis to assume that such life is absent. The majority of scientists propose that owing to the essential difference of the physical conditions on Mars from those of Earth (which are considered to be optimum for the development of higher forms of life) there is absent not only an animal world, but higher vegetation.

The future will tell if this is so, and it is continuously linked with the utilization of direct methods of investigation, in as much as the ground methods (optical and radio-technical) have exhausted their possibilities to a considerable measure. In any case, the information obtained with their help is indisputable.

Another neighboring planet is Venus, located at a distance from the Sun equal to 0.72 of the average distance from Earth to the Sun. It is closer to Earth than Mars, but, in spite of this, we know considerably less about it than about Mars. The mass of Venus is determined quite precisely. It turns out to be close to the

mass of Earth. The dense clouds covering this planet do not permit its surface to be seen.

Very little is known about the atmosphere of Venus. The temperature of the cloud layer, in the opinion of certain foreign astronomers (Sinton and others), is equal to $\neq 39^{\circ}$ C. on the daytime side. The result of determining the temperature of the surface of the clouds is contradictory; certain scientists consider that it is equal to $\neq 200^{\circ}$ C.

A powerful layer of carbon dioxide stretches above the cloud layer; it is several hundred times greater than in Earth's atmosphere. Carbon dioxide, obviously, is the basis of the atmosphere of Venus. Due to the large content of carbon dioxide, some investigators were able to suppose that there is water on Venus or it is completely absent, or, conversely, it completely covers it with a very deep layer. What is this supposition based on, which received the name "oceanic hypothesis"? It is based on the fact that if the composition and evolution of the rocks is similar to the Earth's, then in the presence of water and a contact with the atmosphere, a chemical reaction between magnesium silicate and carbon dioxide, must have taken place, which would have exhausted the atmospheric carbon dioxide.

Argon in the Venusian atmosphere can be present as a product of the radioactive decomposition of potessium, if the latter is contained in approximately the same quantities as on Earth.

At the present time there are more frequent arguements in the use of the "oceanic hypothesis". Separate investigators note patches of sunlight on Venus; they can originate from the reflection of solar rays by a water surface or large accumulations of ice crystals in the clouds.

With the aid of radio-technical methods, what is covered under the cloud layer could be established. American astronomers carried on radar of the surface of Venus. Its complexity is not only in the large power of the installation, but in the difficult task of separating the reflected signal from the radio noise of ou-

ter space. Only after a year of processing the radar results the experimenters were convinced that they actually received signals reflected from Venus. However, the data obtained does not permit the formation of any conclusion concerning the character of the planet's surface; the data did not permit neither a specification of the distance to Venus, nor a determination of its periods of revolution.

Radar of Venus was also done in the Soviet Union. Scientists succeeded in measuring the period of revolution of the planet and specifying the meaning of the astronomical unit.

Until not long ago, there was not a single opinion concerning the size of the period of revolution of Venus around its axis. For example, one French astronomer, Dolfus, proposed that it coincides with the period of revolution of this planet around the Sun and, consequently, is equal to 225 terrestrial days. Others considered it to be close to one terrestrial day. So, an American radioastronomer, Kraus, found that Venus makes one revolution around its axis in 22 hours and 17 minutes.

Due to powerful transmitters, large antennas and sensitive recievers, the Soviet scientists were able to accomplish extraordinarily precise and reliable mesurments. The period of revolution of Venus around its axis turned out to be about 10 terrestrial days.

Another important achievement of the Soviet scientists was the measurement of the astronomical unit (the average distance from Earth to the Sun).

The astronomical unit is a unique scale of units of the Solar System. Mathematical methods of astronomy offer the possibility of determining the distance of the planets from the Sun only in relative values. So, for example, the average distance from Mercury to the Sun is equal to 0.387099 astronomical units (the average distance from Earth to the Sun). Not knowing the exact value of an astronomical unit, we are not able to determine the distance of the planets from the Sun, and their distance from each other.

Photograph of the visible side of the Moon. Astronomers, beginning with Galileo, looked at the visible side of the surface of our permanent satellite in telescopes. By means of these observations and photographs its relief was studied in detail. With the investigation of the heat radio-emission of the Moon the physical properties of its surface are studied. With the aid of spectroscopic methods, it is established that the Moon is not dead, that some vulcanic activity takes place on it. But much data concerning the Moon remains unknown or debatable. That is why the first terrestrial space rockets were guided to the Moon. From now on the Moon will be a tempting object of space explorations with the aid of rockets and artificial satellites.

Venus is located at a distance of 0.723332 astronomical units from the Sun. It is obvious that the average distance between the orbits of Venus and Earth is equal to 0.276668 astronomical units. Therefore, in measuring the distance by radar between Venus and Earth and knowing the position of these planets on the orbits,

we can compute the value of the astronomical unit. It turned out to be, as the Soviet scientists established, 149,457,000 km.

The Moon, a natural satellite of our planet, is located immeasurably closer to the Earth than the other celestial bodies. The distance to it is 384 thousand km. It practically does not have an atmosphere. It is also impossible to consider that the surface of the Moon is completely studied. And this is in spite of the fact that the Moon has been seen through a telescope since Galileo's time and detailed charts of its surface have been composed. What is the matter? The Moon always turns one side towards the Earth; consequently, a complete study of its surface could only be made with the help of rocket methods of exploration.

The Moon has a mass approximately eighty times less than Earth's, and a radius four times less. Gravitation, therefore, on the Moon is six times less than terrestrial gravitation. It is insufficient for maintaing an atmosphere -- gases from the Moon must volatilize much faster than those from the Earth, and at those temperatures which they must have on the Moon. But an atmosphere can exist as a certain equilibrium state between volatilization of gases and their generations (origination). According to one of the hypotheses, radioactive decomposition of potassium (argon is formed) or chemical processes in the bowels of the Moon (sulfuric gas, carbon dioxide and water are formed) could be sources of the formation of the gases.

What would approximate estimates of the emission of gases be along with the speed of their dispersion under conditions of weak gravity and the action of corpuscular currents of the Sun (the so-called "solar wind"), if we consider that the Moon is not protected from them by a magnetic field? The density of the atmosphere of the Moon may consist of 10^4 particles/cm^3 (or 10^{-15}atm.) for argon and 10^8 particles/cm^3 (or 10^{-11} atm.) for the other gases. Experimental data, obtained with the aid of indirect ground methods of investigation, provided a basis to suppose that the density of the atmosphere on the Moon is not more than 10^{-13} atm.

At such a low atmospheric density, it is, of course, impossible to assume that there is water on the surface of the Moon. The lunar atmosphere, undoubtedly, is completely ionized, which makes the measurement of its density possible with radio methods.

Measuring temperatures on the basis of heat, infrared surface radiation and radio-emissions of the Moon in the centimeter band permits an estimation of the size and variation in temperature of the lunar crust on the surface and to a slight depth. This "transparency" of the substance of the lunar crust for radio waves depends on the length of the wave -- the larger it is, the fewer the radio waves that are absorbed. Waves 3 cm long correspond to a 10-15 cm layer and waves 20 cm long correspond to a layer approximately one meter thick. The surface temperature can be determined on the basis of the thermal radiation in the infrared part of the spectrum.

The results obtained testify to the fact that the temperature of the surface of the Moon varies in the ranges from -120° to -150° C. The deeper the layer of the Moon being investigated, the smaller the band of temperature fluctuation. On the Moon these fluctuations fade very rapidly, at a depth of several centimeters. This permitted the conclusion that the lunar surface consists of a material of low heat-conductivity. And these can be only materials with a porous structure and reminiscent terrestrial tuff or a layer of dust.

Not long ago, a Soviet astronomer, N. A. Kozyrev, with the aid of spectral methods of investigation, discovered the ejection of gases on the Moon from its depths in the region of the Alphons crater and obtained spectrograms of it. What does this mean? The Moon is not a dead world; it lives right now with its own complex internal life.

The character of the Moon's surface and its numerous craters is a big mystery. Investigators of the Moon are divided into advocates of the vulcanic theory of the origination of craters and the meteoritic theory. These and others are leading the

weighty proofs to the use of their hypotheses, but the verification of their authenticity is a job of the future, when rockets from Earth will study the Moon in detail.

The origination of the Moon also is not clear. Many scientists consider that the origin of Earth and the Moon is common. One scientist maintains that the Moon broke away in due time from the Earth upon passage near the Earth of some celestial body; another claims that the Earth and Moon were formed from one dust cloud.*

Not long ago, Bulgarian scientists expressed an original hypothesis that at some time the Moon was an independent planet with violent vulcanic activity. The powerful and frequent eruptions created reactive acceleration on this planet, similar to that which an engine transmits to a rocket. As a result of the chaotic action of these forces, at the moment of the termination of the work of the "vulcanic engine", the Moon turned out to be close to the Earth and was entrapped by the force of its gravity.

It is hardly possible to obtain any substantial and unconditionally reliable information concerning the closest neighbors of the Earth with the aid of terrestrial means and methods of investigation. To accomplish further investigations, there must be instruments, carried by rockets in the vicinity of these planets or transporting them to the surface. Depending on the results of the investigations, we will be able to determine the features of the structure of the planets and the physical conditions on them, the means of further study of the planets, the ways and dates of populating them with people.

Rockets help to fill in the missing links and in studying other planets of the Solar System: Mercury, red hot on one side and buried in permanent cold on the other; the thundering atmosphere, mysterious red space and ice-covered satellites of Jupiter; the encircling ring of Saturn; Neptune, Uranus and Pluto, located at great distances from the Sun; the zone of numerous asteroids. We know even less about all of these celestial bodies than about the neighbors of the Earth.

Rocket methods of exploration are necessary for the study of comets, stars and stellar systems. And the problem is not only in the possibility of manned flight to other worlds. Leaving the limits of the terrestrial atmosphere, and the transporting of optical instruments there undoubtedly enlarges the possibilities of spectrometric investigations of specific celestial bodies in those portions of the spectrum, for which the atmosphere is an inpenetrable light-filter.

CHAPTER 2

What the Rockets Told...

Concerning the fact that the density of the air at any altitude above the surface of the Earth is equal to so many grams per cubic centimeter; the energy of the charged particles in the radiation belts of the Earth consist of so many thousand or million electronovolts; annular currents exist in the ionosphere and in the radiation belts of the Earth...

--Well, what of it?--asks some reader. --I am not a specialist, this does not mean anything to me...

This is true. Each individual fact, even the most interesting, means little in itself. It is necessary to know the history of its discovery and its role in the general complex of knowledge: to know how to present in a logical way its influence on the ulterior development of our knowledge about nature. If this does not occur, not one firgure, nor one fact will mean a thing, whether it is a separately read letter or even a word in the most interesting book.

Penetration into outer-space and the possibility of immediate measurement of any amounts does not indicate their chaotic, random accumulation. Above all, we must obtain authentic data for the verification of any suppositions concerning the structure of the Earth, Solar System, the Universe or even simply a small specific corner in them for solving any disputable question. Penetration into space is necessary in order to find the key to the mystery of the mechanism of any natural process, which we encounter in life.

The Rocket is a weapon of science. Scientists of many countries in their own territories and in oceans investigate the physics of the atmospheric processes with the aid of various direct and indirect methods. But investigations into specific areas did not provide a general picture, and even if they were conducted at large adjacent parts of the Earth, it was frequently impossible to tie them together. It was explained that they existed in a different time, by various equipment, the reading of which is difficult to compare, or observations at any part were not executed. And this already can be compared to a books, in which there is no complete subject, the separate chapter are badly tied together, and, in addition, the majority of the pages are torn out. Try to understand its contents!

Over a certain period of time, scientists of many countries decided to conduct a detailed observation over the natural processes in the entire planet. This grandiose scientific undertaking received the name of the International Geophysical Year (IGY). It was conducted in 1957--1958.

Thousands of terrestrial stations, hundreds of expedition ships conducted regular measurements in various parts of the planet. A white unpopulated continent--Antarctica-- was covered with a network of scientific stations, several drifting stations operated on the ice of the poler bassin.

And the atmosphere? Radio- and aircraft sounding makes it accessible up to altitudes of two to three tens of kilometers. This is insufficient for studying the general structure of the atmosphere. An entry into its upper layers is necessary. Investigations beyond the boundaries of the dense atmosphere are needed also for studying the ionosphere, the flow of radiation of the Sun at its outlets or at least the place where it breaks into the atmosphere of the Earth, causing its ionization, heating and motion.

Here is where the irreplaceable rocket methods of investigation come in. Towards the beginning of the IGY they were sufficiently well developed and widely utilized in the Soviet Union and in the U.S.A.

How is rocket sounding of the atmosphere accomplished?

The vertically launched rocket carries equipment which measures the pressure of the atmosphere, temperature, ion composition, radiation of the Sun, cosmic rays and so forth on the ascending and descending portions of the trajectory. The instrument readings are transmitted to the Earth with the aid of radiotelemetric devices or measures are applied to return the rockets to Earth with the registered results of the measurements.

The launching of a rocket can be done both immediately from the Earth and from a balloon elevated to a great altitude and acting as the first stage of the rocket. Such a launching plan permits the obtainment of gains in altitude by the attainable rocket. But a rocket that can be launched with a ballon slowly passes the lower layers of the atmosphere and cannot be useful for observation of rapidly changing phenomena, as, for example, the flashes on the Sun.

What are the results of the rocket explorations of the atmosphere that were conducted in the Soviet Union? With the aid of rocket investigations information is obtained concerning the density of the air and the temperature of the upper layers of the stratosphere according to altitude, and meteorological sounding of the stratosphere is carried out. The program of sounding is constructed in such a manner as to obtain data concerning the distribution of these magnitudes in various latitudes of the globe, to recognize their changes during a day and from season to season. In terms of the language of geophysics, to study their latitudinal, daily and seasonal variations.

An important feature of the Soviet rocket explorations is the striving to obtain possibly a greater quantity of data in the process of each launching, and to make the experiments full-scale. The changes in any of the values can depend on the changes in some other values. We can confidently judge concerning the physical connections of these or any values can be only in a case when all data on the changes in many parameters obtained in this launching is at the disposal of the

experimentor. From a scientific point of view, such an experiment is undoubtedly more valuable than if all the measurings composing it could be done in various rockets and at a different time.

Such full-scale experiments were accomplished in geophysical rockets. The exclusive possibilities for this created great powers of the engines of the Soviet rockets. All the necessary equipment and experimental animals were able to be placed in the instrument containers.

With what is connected the arrangement of biological experiments for explaining the influence of specific conditions of rocket flight in the upper atmosphere and its physical conditions on the state of the animals? An important feature of such rocket explorations is the recovery of the rockets and instrument containers upon their fall to the Earth. This permits an unharmful recovery of the instruments and experimental animals. Many of them are already veterans of space flights and repeatedly ascended to the surface of the Earth's air ocean.

In the Soviet Union during the IGY and an additional period, the International Geophysical Collaboration (IGC), which encompassed all of 1959, 175 rocket launchings (125 during the IGY and 50 during the IGC) were made. In coorespondence with the program, these launchings were made in polar areas -- on Kheysa Island (Franz-Josef Land) and near the Mirnyy Soviet South Pole Observatory (from ship-board); in the northern waters of the Pacific Ocean; in the equatorial latitudes (also from ship-board). 158 meteorological rockets and 17 geophysical rockets were launched.

Rocket sounding of the atmosphere according to the IGY program was also conducted in the USA and to a smaller extent in Japan and England. Several American rockets were launched by Canadian scientists. Can we assume that the entire globe was encompassed by the rocket sounding?

This is all good, but is it really enough? What is the rocket could have obtained scientific information not only over one certain point, but over large

territories, and during long time intervals!

Geophysical rockets at the moment of launching. These powerful rockets carry many different kinds of instruments to an altitude of several hundreds of kilometers. The significant payload of the geophysical rockets permits us to make complex experiments and to obtain in each launching data which can be compared with one another. The large payload also permits us to conduct biological experiments on the geophysical rockets.

A rocket engine cannot maintain a rocket at an altitude for a long time; it is necessary to search for other methods of overcoming gravitation.

Nature pointed out them to man: the motion of the Moon around the Earth, the motion of the Earth and other planets around the Sun.

It is necessary to give horizontal speed of a determined amount to the instrument container, enough to move it along a closed orbit around the planet, -- to create an artificial Earth satellite.

Now satellite is an ordinary, familiar word, found in every language. Four or five years ago, in the preparation period of the IGY, a declaration of the governments of the Soviet Union and the USA concerning the intentions of these countries in launching artificial satellites according to the IGY program sounded, if you please, even somewhat fantastic.

The wide reclaim in the USA created an impression of full readiness of this country for launching satellites. But the first satellites were launched in the Soviet Union. And what satellites! Not those miniature in size and weight, which the USA launched, but gigantic geophysical stations, flying laboratories with exclusive possibilities for carrying out complex scientific experiments.

The first Soviet satellite in its shooting motion visible at any point of the Earth destroyed the myth of foreign propaganda concerning the technical backwardness of the Soviet Union.

Soviet scientists were not striving towards the solution of partial problems, but began to make experiments on the satellite universal.

This brought about great difficulties. It could easily be accepted that satellite investigations could prove to be unsuccessful only due to incorrect estimations of the factors to be measured. The physical conditions on the satellite itself could complicate the work of any instrument. It followed to approach the solution of these problems step by step, think out every step of the investigations, try to obtain the maximum scientific effect. All these considerations specified the sequence of the experiments, which were conducted on Soviet artificial Earth satellites.

The first Soviet satellite permitted the obtainment of data on the upper ionosphere and on the conditions for providing radio communications with the satellite and on the temperature conditions inside the satellite. This was necessary in order to explain the conditions in which the instruments must have operated and the existance of the first space traveler -- a dog named Layka, who left

the planet on the second satellite on 3 November 1957.

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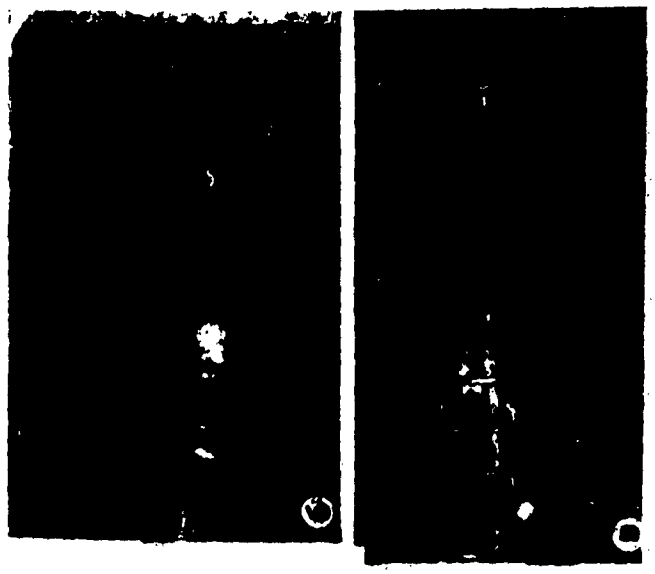

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The First Soviet Artificial Earth Satellites

a--This gleaming sphere is the first artificial Earth satellite in the world. It was launched in the Soviet Union on 4 October 1957, the year commemorating the 100th anniversary of K. E. Tsiolkovskiy's birth, the year in which his foresight was transformed into life, a symbol of the beginning of the space age. The first artificial satellite permitted planetary explorations of the density of the atmosphere and the ionosphere, and the temperature conditions of the satellite.
b--The second artificial satellite permitted the broadening and expansion of the program of geophysical investigations, beginning with the launching of the first satellite. (continued on next page)

The large weight of the satellite permitted a biological experiment to be conducted on it, in order to study the influence of prolonged space flight on a living organism.

c--The third Soviet satellite, as both of the two predecessors, was launched according to the program of the International Geophysical Year. The large quantity of various instruments, located on the satellite, permitted the performance of experiments in studying the upper atmosphere and outer-space, the obtainment of many comparable results. The launching of the third satellite helped the Soviet scientists to immediately carry out all the corresponding divisions of the IGY program, taken on by the Soviet Union.

The second satellite, by way of a biological experiment, permitted the estimation of the amounts of cosmic radiation in various geographical latitudes, the discovery of the polar areas of the outer zone of the Earth's radiation belts, and the careful preparation and conductance of experiments on the third satellite.

The third satellite, launched on 15 May 1958, weighed 1327 kg. Only the weight of the equipment and power sources was 968 kg. This was reflected in the striving of the Soviet scientists for the complexity of the investigation and greater powers of the Soviet rockets.

This satellite permitted the accomplishment of an entire division of the IGY program, taken on by the Soviet Union. It made over 10,000 revolutions around the Earth. The use of solar batteries as power sources permitted the obtainment of scientific information during a large interval of time, taking up a significant portion of the IGY and all of the IGC period.

In 1958 American satellites also took part in the IGY program. The first of them, "Explorer-1", was launched on 1 February. Due to the small power of the rockets on the first American satellites it was impossible to distribute a sufficient amount of the equipment. Their launching, as a rule, took on the character of a partial physical experiment. A satellite with a full-scale program of investigations, "Explorer-VII", was launched only at the end of 1959.

It is impossible not to note the internationality of the investigations with the aid of satellites. Scientists of all countries could follow their movements and receive radio signals. There are several reasons for this. In the first

place, the Soviet satellites had a large deviation of orbits toward the plane of the equator and could therefore be observed over the territory of any country. Secondly, the large dimensions of the Soviet satellites alleviated the performance of optical and photographic observations of them. In the third place, the large power of the radio transmitters of the Soviet satellites alleviated radio tracking, and the operating frequencies of these satellites (20 and 40 cps) differing from the frequencies of the American satellites (108 cps) permitted the accomplishment of ionospheric investigations (on the basis of observing the passage of radio waves through the ionosphere).

In its motion a satellite envelopes larger spaces, it exists for a long time, and the solar batteries prolong the operation of its instruments. Does this mean that rocket sounding has no meaning for satellites? Of course not. A satellite cannot move along an orbit lower than altitudes of approximately 160--170 km. The whole thickness of the atmosphere lower than these altitudes is insufficient for direct investigation from an artificial Earth Satellite. A satellite does not offer the possibility of performing a vertical cut of the atmosphere. It cannot conduct measuring in a given point in any desireble moment of time. In this are basic short-comings of it in comparison to rocket sounding. Consequently, only an intelligent computation of the investigations with the aid of rockets and satellites can present a clear picture concerning the structure of the atmosphere, its motions.

The study in the Soviet Union and USA of the atmosphere with the aid of rockets and satellites according to the IGY program permitted the obtainment of the first reliable information concerning it. Investigations with the aid of rockets and artificial satellites of the radiation of the Sun and the Earth's magnetic field permitted the discovery of a radiation zone around the Earth, the ionosphere and outer-ionosphere currents.

The International Geophysical Year was not even over and new tasks were facing the investigators.

Our powerful, technically perfected rockets brought into orbit satellites of enormous weight, equipped with a large amount of scientific apparatus. This created favorable conditions for conducting scientific investigations. It could already be seen then, that in the power of Soviet science was not only the entry of the satellites into orbits near the Earth, but also in reaching the remote environs of the Earth. And actually, the Soviet rockets soon overcame the next space barrier.

The first space rocket was shot up on 2 January 1959 to side of the Moon, and going on a given trajectory in an immediate distance from the permanent satellite Earth, went into orbit around the Sun, and became the first artificial planet. In this manner, the second cosmic velocity was overcome, or the velocity of liberation, equal to 11.2 km/sec. at the surface of the Earth. The body, having obtained this velocity, always leaves the Earth's gravitational field.

The immediate study of the Moon was the purpose of the next launchings. The second Soviet space rocket, which took off on 12 September 1959, reached the surface of the Moon on 14 September, and was established there as a symbol of man's creativity over the forces of nature, the banners of the Soviet Union.

The fundamental purpose of this first interplanetary flight was the continuence of the explorations of outer-space, the nearer regions of the Earth and the Moon and the Moon itself. The great power of the engines of the multi-stage rocket permitted the accomplishment of a complex experiment, the obtainment of the first information on the physical features of the natural satellite of our planet.

The launchings of the Soviet satellites and the first space rockets were distinguished by high precision. The third Soviet space rocket entered on 4 October 1959 into a complex spatial orbit around the Earth and Moon and launched a automatic interplanetary station. This station, on commands from the Earth,

orientated the photo devices installed on it to the Moon. For forty minutes it photographed the reverse inaccessible examination of side of the Moon from the Earth, processed the photographs obtained and then, upon approaching the Earth, it transmitted these photographs and sent them to the people. On the claims of the first discoverers, the Soviet scientists gave names such as new "sea", "mountain", "cirque". An Atlas of the reverse side of the Moon was published by the Publishing House of the Academy of Sciences USSR, and in it are shown the results of this complex, distinctively accomplished space flight.

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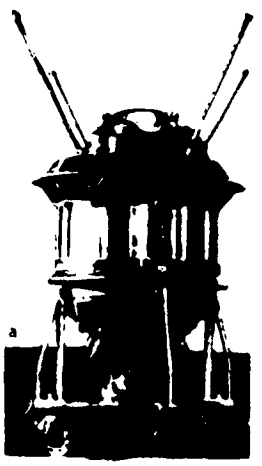
The first Soviet space rocket. General view of the nose cone (a) and instrument capsule (b). Launched 2 January 1959. This was the first space craft created by human hands, which differs from artificial satellites in that it never returns to Earth. Of course, it is impossible to exclude the possibility that man will be able to ultimately find it in interplanetary spaces and, returning to Earth, place it in a museum. It served us to a greater extent than Nansen's "Fram", Heirdal's "Kon-Tiki" or even the boat of Peter I. A scientific apparatus, located in the capsule of the rocket, permitted the obtainment of the first data on the physical processes in interplanetary space and in the vicinity of the Moon.

The launching on 12 February 1961 of a Soviet rocket to Venus was a new and great achievement of science and technology. It is known that for such a flight incomparibly higher accuracy is required than anything previously achieved. The

accuracy of the successful flight is even more astonishing, since the flight of the space rocket and the automatic station located on it was accomplished according to an original, not earlier used plan: the rocket was launched from a heavy artificial Earth satellite. It in turn led the automatic interplanetary station on a trajectory towards Venus.



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Automatic Interplanetary Station, Guided into Orbit by the Third Soviet Space Ship.

a--General view of the station on mounting cart.
b--Diagram of photographing the Moon.

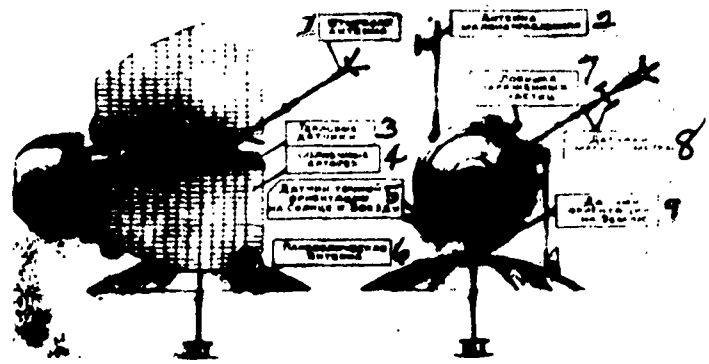
AIS -- the first automatic installation, which went towards our cosmic neighbor, the Moon. In obliging the wish of the people who sent it up, the AIS photographed the invisible side of the Moon and transmitted the photographs obtained to the Earth together with the results of other experiments in the study of outer-space.

At the end of May 1961 the station crossed the orbit of Venus in a point, where Venus turned out to be at approximately this time. The distance between this meeting point and the Earth consisted of approximately 80 million km.

This is not the shortest distance between Earth and Venus, which is approximately equal to 40 million km. What specified such a selection of a meeting point? The fact that at the shortest distance, Venus is located between the Earth and the Sun. The radio emission of the Sun can smother transmission from an interplanetary station, and communications with it turns out to be impossible.

Automatic interplanetary station, launched to Venus 12 February 1961, on mounting platform (a) and diagram of its installations (b).

In the second half of May it came close to Venus, passing it, according to calculated data, at a distance less than 100 thousand km. This is a result exclusive in its precision.
The launching of the AIS was accomplished from a heavy artificial Earth satellite, guided onto circular orbit by a powerful rocket.



Key to (b): 1. Spike antenna; 2. Small-direction antenna; 3. Heat units; 4. Solar batteries; 5. Unit of precise solar and astral orientation; 6. Parabolic antenna; 7. Charged particle catcher; 8. Magnetometer units; 9. Earth orientation unit.

The weight of the automatic interplanetary station is 643.5 kg. This is not simply a technical record like those, which the aviation federation registers. In space ships, in interplanetary stations and in satellites it is impossible to carry an excess load into orbit. Every gram of their weight works and bears determined responsible duties according to the assigned program of investigations and

transmits their results to Earth.

The weight of the automatic interplanetary station -- this is the scientific apperatus for investigating cosmic radiation, magnetic fields, interplanetary matter and registering collisions with micrometeors. The weight of the station -- this is the system for regulating the temperature inside it to assigned limits, a radio system, designated for transmitting scientific information and reports on the operating conditions of all systems and units. The weight of the station -- this consists of the chemical power sources, the solar batteries, the system of solar orientation, elements of the construction etc.

In the 15 May 1960 launching a series of experiments was started on guiding space ships weighing more than four and a half tons onto the orbit of the Earth satellite. The orbits of these ships were practically exactly round, which testifies to the high accuracy of their entry.

Three ships, according to a planned program, were returned to Earth together with all the scientific apparatus, with "zoological gardens" on the ships. This problem could not be solved without reliable stabilization of the ship in flight, precise work of the engines and the entire complex of landing gear.

The precision of the guidance of the Soviet rockets was demonstrated in this experiment not only as a result of the entry of the space ships into orbit. The second space ship flew in the course of 24 hours on a path, approximately equal to the distance to the Moon and back. Then, with the greatest precision for the first experiment, (the deviation consisted of less than 10 km) it landed in the assigned region. Another part of this landing stands out: it was performed so accurately, that not one of the animals located in the ship and capsule suffered, and the ship itself turned out to be completely suitable for utilization again.

The fourth and fifth space ships landed precisely in the assigned region.

The successes of the development in the USSR of rocketry and space explorations is impossible to explain by good luck. Our country has a powerful technical base,

and qualified specialists. The economic and socialist structure of our society made the success of the Soviet Union regular.

The rockets and satellites created exclusive possibilities for a number of sciences: geophysics, astronomy, biology, meteorology, geology and others. They made a realistic statement of such problems, which were hard to dream about even ten years ago. Some of them are already being successfully solved.

K. E. Tsiolkovskiy called the Earth the cradle of the mind. The first "glance" of the instruments, sent beyond the limits of the atmosphere, was directed namely to the side of this cradle, the first artificial Earth satellites were geophysical. They were designated for accomplishing scientific investigations according to the program of the International Geophysical Year.

What scientific results are obtained with the aid of rockets and satellites?

Radiation belts. The mechanism of the motion of charged particles is not complex. Under the action of a magnetic field of the Earth they begin to move along magnetic power lines, at the same time revolving around them. The trajectory of the motion of the charged particles as if "climbing" to the magnetic power line, appears to be spiral. Depending on the energy, the mass of the particles, the place and direction of its motion in the Earth's magnetic field, the character of the trajectory of the particles, "selection" of any magnetic power line on which it will "climb", will be determined.

But from what has been said, it does not follow at all that a particle fell into a trap. It would seem that it must pass along a power line and lose its energy upon approaching towards the Earth.

So it would be, if in the approach to the magnetic pole the particle were not to overcome the resistance of the thickening magnetic power lines. It, as in the resistance of a spring in a mechanical motion, slows down the motion of the particle along the magnetic power line. Then the particle stops and begins to move backwards. It is as if thrown out by the magnetic field from the polar area along

the same power line. This reverse motion gradually is accelerated. In the point of passage of magnetic equator the velocity of the particle reaches the greatest value. Then, as it approaches another magnetic pole of the Earth, slowing down again begins. This phenomenon is repeated again and again.

Photograph of the Earth from a high-altitude rocket. The Earth is seen from an altitude of several hundred kilometers. The rapid flight around the Earth by the satellite, the utilization of complex and precise apparatus led to the fact that now we are studying our planet as a whole. We can determine its exact shape, study the magnetic field at great distances from the terrestrial surface, examine details of atmospheric phenomena and study the general regularities of atmospheric and marine movements, which is extremely necessary for a concept of the physical mechanism of the natural processes. It is in turn necessary for fore-casting such processes, and ultimately for active intervention of man into them.

The aurora borealis is an exceptionally beautiful sight. It occurs at altitudes from approximately one hundred to one thousand kilometers. Its appearance is accompanied by magnetic storms. An attempt to physically explain this phenomen led many scientists to the conclusion that the aurora borealis is caused by charged particles, caught by a magnetic field and held in it for a long time. This

proposal was expressed and physically founded back in 1911.

In the beginning of the rocket and satellite investigations of the Earth's atmosphere the task of studying these particles caught by a magnetic field had not been set. Therefore, to a certain extent, the result obtained by the Soviet scientists proved to be unexpected upon studying cosmic rays on the second and third Soviet artificial satellites, and then by American scientists on "Explorer-III" and "Explorer-IV".

This unexpectedness is not only in the discovery of an area of increased intensity of radiation, an increase in the quantity of particles of high energy, falling into the registering instrument in a unit of time, but in the divergence of the data obtained by Soviet and American investigators. With the aid of the second and third satellites a sharp increase in the intensity of cosmic radiation with an increase in geographic latitude and simultaneous increase in altitude was discovered. The results obtained by American scientists told of the increase in intensity of radiation with altitude and of the absence of the dependency on latitude.

It was clear that the increase in intensity of radiation was due to the capture of these particles and the holding of them in an unusual trap by the Earth's magnetic field. But what did the divergence explain? Maybe, the secret lies in the peculiarities of the orbits of the satellites and in the structure of the radiation zone around the Earth?

The Soviet satellites had greater inclination of orbital plane towards the equatorial plane than the American satellites, which permitted them to reach the polar zones, but on the other hand, they had smaller altitudes of apogee[1]. This means that it would be completely possible to assume that the zone of radiation has a complex structure. Its "internal zone", beginning at great altitudes, was practically not reached by the Soviet satellites. But the lower edge of this zone

1 Apogee -- the greatest distance from the earth's surface to an orbital point of a satellite.

was captured by American satellites. The "external zone", located at very great distances from the terrestrial surface and with its extremities penetrating comparatively deep into the polar atmosphere, was discovered by Soviet satellites.

This was plausible, but required verification, which could be accomplished only by means of a vertical cross section of these zones or belts of radiation. This task was set before the launching of an American rocket to the Moon in December 1958 and at the launching of the first Soviet space ship on 2 January 1959. During these launchings the structure of the Earth's radiation belts was subjected to a detailed study.

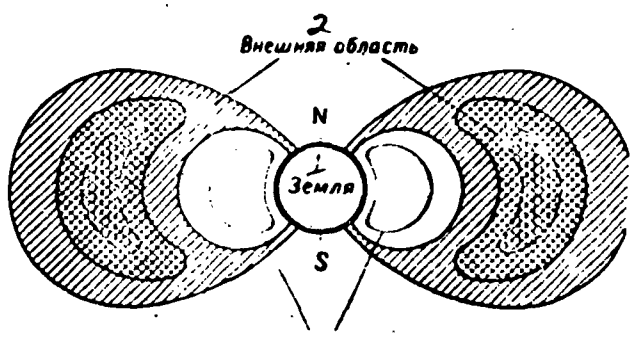
It is interesting to note that the unsuccessful attempt of the American scientists in their basic goal, to put a rocket on the Moon, led to unexpected success in studying the structure of the radiation belts of the Earth. The rocket, having reached an altitude of 107 thousand km, fell back to the Earth and in this manner made a vertical cross section of the radiation zones of the Earth not only at the ascending portion of the trajectory, but at the descending portion in a somewhat different direction.

The proposals concerning the structure of the radiation belts of the Earth, which were made after their discovery with the aid of artificial satellites, were confirmed as a result of the launching of the first Soviet space ship and the American rocket "Pioneer-III". The following launchings of Soviet and American space ships also permitted the obtainment of data on the structure of the radiation belts of the Earth, and on their variations in the course of time.

Magnetometers, installed on the Soviet space ships, provided the possibility of discoverying a system of currents in the radiation belts of the Earth, that was not only the best information of their existance, but to a certain extent characteristic of their mechanism.

Additional information on the radiation zones of the Earth was obtained also with the aid of launchings of satellites and high-altitude rockets. It was dis-

covered that these zones are not symmetrical relative to the center of the Earth; over the western hemisphere (over America) the internal zone begins at an altitude of approximately 600 km, and over the eastern hemisphere (over Australia) at an altitude of about 1600 km. The reason for this, as one might guess, consists in the peculiarities of the structure of the magnetic field of the Earth -- in the experiment -- the non-coincidence of its "center" with the geometric center of the globe.



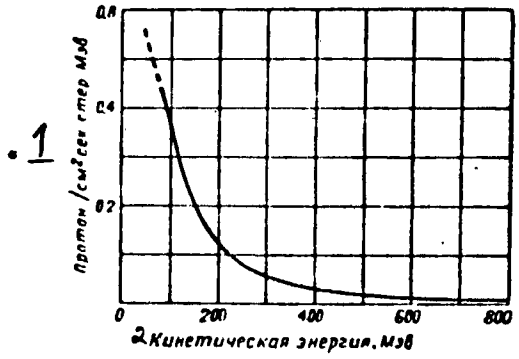
The radiation zones of the Earth. This is a cloud which is colossal in its dimensions composed of charged particles, caught by the magnetic field of the Earth (N and S -- north and south geomagnetic poles). It extends for several tens of thousands of kilometers from the terrestrial surface and consists of two concentric extremities-zones: external and internal. The external zone was discovered by Soviet investigators with the aid of the second and third artificial satellites, the internal zone was found by American investigators by means of "Explorer-III" and "Explorer-IV".

KEY: 1. Earth; 2. External area; 3. Internal area.

This non-coincidence was known earlier, after ground investigations of the magnetic field. But the data obtained upon studying the zones of radiation, compelled a re-examination of this experiment. If earlier it was considered to be equal to 300 km, then now it has increased to 500 km.

The internal zone has a maximum distance from the surface of the Earth of approximately 2--3 thousand km and ends at a distance of 3--4 thousand km. The external zone begins at a distance of approximately 10--11 thousand km, has a maxi-

mum distance of 20 thousand km and extends up to 40--50 thousand km from the surface of the Earth.



Spectrum of energy of charged particles in the internal radiation zone of the Earth.

KEY: 1. Protons/cm^2 sec Ster. MeV; 2. Kinetic energy, MeV.

The energy of the particles lies along the horizontal axis, and the flow of charged particles, or the intensity of radiation, along the vertical axis. The curve indicates the relation of the particles of various energies in the internal radiation belt. The basic part of the protons has energy of about 100 MeV and the relative number of particles with an energy greater than 200 MeV is comparatively small.

Upon studying the zones of radiation, it was established that the internal zone consists of basically protons with high energy, about 100 million electronovolts (MeV). The external zone mainly consists of electrons with comparatively low energy -- 30-100 thousand electronovolts.

In the southern part of the Atlantic Ocean in the "internal surface" of the radiation zones there is an unusual depression. It matches up by having a magnetic anomaly. The border of the radiation belt descends here to an altitude of approximately 300 km.

Upon a study of the radiation belts of the Earth it was also discovered that the external zone is not stable in time, that its configuration, concentration and

energy of its particles change. At the same time, the internal zone remains relatively stable.

The causes of these changes lie in the inconstancy and instability of the "work" of those sources of charged particles, from where they fall into the "magnetic trap" of the Earth.

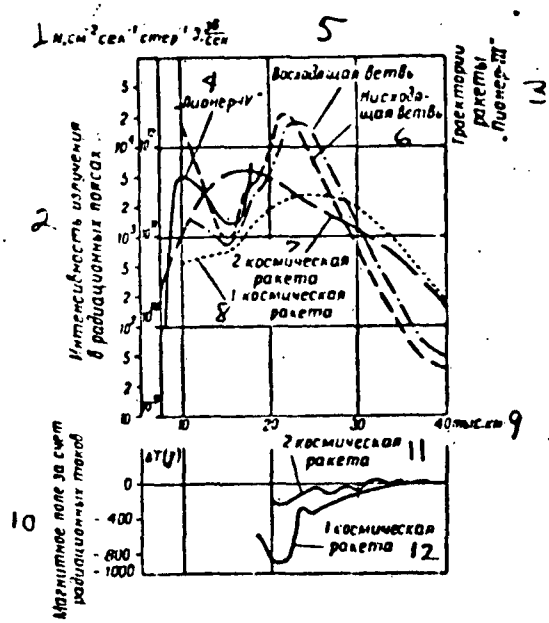
Due to the collisions of particles of the radiation belts of the Earth with gas and dust particles of an interplanetary medium, molecules and atoms of the exosphere -- the uppermost part of the Earth's atmosphere -- a certain quantity of particles, composing the belts of radiation, constantly loses its energy, which the variation of the zones of radiation of the Earth in time to a certain extent depends on the irregularity of the departure of the particles; the concentration of the gas and dust particles in interplanetary space is greatly changed. Such a proposal is not very probable, more so that the relative role of these particles in dispersing the particles from the Earth's radiation belts is comparatively small.

This means that the instability of the departure of the particles from the radiation zones may be explained by the variability of the quantity of molecules and atoms of the atmosphere, with which collision of high-energy particles may occur. Such an explanation is plausible.

After careful processing of the results of the measurements conducted with the aid of the first Soviet space ships, data was obtained on the fact that at altitudes of 50--75 thousand km, i.e. beyond the limits of the external radiation belt, there are flows of electrons with energies exceeding 200 electronovolts. This permitted the assumption that a third radiation belt also exists. Its characteristic is a large intensity of flows of charged particles at comparitively small energies. The data obtained in the launching of the American rocket, "Pioneer-V", in March 1960, confirmed the assumption of the Soviet scientists.

The flights of the second and third Soviet satellite ships provided the possibility of composing a chart of the distribution of radiation according to inten-

sity on the surface of the globe.



Change in the Intensity of Radiation in the Radiation Zones In the Course of Time.

Key: 1. $N_2CM^{-2}sec^{-1}ster.^{-1}$ $\frac{36}{J}$, sec; 2. Intensity of radiation in radiation belts; 3. Trajectory of "Pioneer-III"; 4. "Pioneer-IV"; 5. Ascending arm; 6. Descending arm; 7. 2nd space rocket; 8. 1st space rocket; 9. Thousands of km; 10. Magnetic field allowing for radiation currents; 11. 2nd space rocket; 12. 1st space rocket.

The radiation zones of the Earth, in particular the external zone, are not stable in time and space. Measurements performed on various space rockets provide substantially different results. It is characteristic that these changes are seen even in the results obtained with the aid of the American rocket, "Pioneer-III" on the ascending and descending arms of its trajectory. Deviations in the amount of stress of the magnetic field from calculations obtained with the use of the first and second Soviet space rockets and compiled in the lower part of the graph, influence the presence of large current systems in the maximum area of the external zone and the variability of these systems in time.

What is the source of the particles for the radiation zones of the Earth?

At the present time it is accepted to consider that there may be two of these sources. One of them is the Sun, which is constantly throwing out clouds of char-

ged particles of high energy, part of which can be trapped by the Earth's magnetic field, when it falls into the "sphere of its action".

The use of this proposal indicates the close connection between the changes in the external zone, its dimensions, intensity of radiation, remoteness of radiation maximum, with magnetic storms and the aurora borealis. The aurora borealis is connected with the change in solar activity. The data possessed provides a basis to propose that the closer the radiation maximum in the external zone is to the surface of the Earth, then the stronger the magnetic storm was, which was preceeded by the formation of the zone.

Another source is cosmic radiation. Particles of this radiation have too much energy to be suddenly caught by the magnetic field. They penetrate through the field, only somewhat changing the direction of motion, and reach the upper atmosphere. After collisions with gas particles, new particles are formed with less energy. Among them are neutrons. Neutrons are electrically neutral and pass freely through magnetic fields. They could, depending on the flight direction, move either up to a new collision with gas particles or generally leave the Earth and move into outer space. But it turns out that the independent life-time of a neutron is comparatively short and it quickly decomposes with the formation of two charged particles: a neutron and an electron. They can already be trapped by a magnetic field and supplement the supplies of particles in the magnetic trap.

For a long time there did not exist a single opinion in relation to the amount of the stock of solar activity in the formation of the Earth's radiation zones. Now it is accepted to assume that the external zone is formed solely due to solar activity, and decomposition of neutrons, "Earth radiation", may play a significant role in the internal zone.

At the present time, the cause has not been established for the existance of a stable "clearance" between the external and internal zones -- the decreasing of the concentration of charged particles.

The interaction of the Earth's magnetic field with charged particles of high energy offers a substantial proposal that the particles, which by some means have fallen into the magnetic field, will be trapped outside the dense atmosphere. If these particles enter any restricted area, then they, evidently, are not spread out through the entire radiation zone. They also do not stop on any insulated power line. At the motion of the particles along a line a "drift" (migration) of electrons towards the east, and protons towards the west takes place. As a result of this drift the Earth turns out to be trapped by an unusual thin shell of charged particles, which had fallen into the magnetic trap.

At the present time only one specific source of charged particles is known, an atomic explosion. Namely the atomic explosions at great altitudes which were used by the USA in the so-called "Argus experiment". The fundamental purpose of this experiment, of course, is not in the explanation of the mechanism of the existance of the Earth's radiation zones: it is known. It was necessary to investigate the possibility of shielding radar stations with an artificially created shell of charged particles for the detection of ballistic rockets and to study the influence of such a shell on the nuclear charge of a rocket passing through it.

The atomic explosions made by the USA which caused some enlargement in the content of radioactive isotopes in the atmosphere did not justify any geophysical problems. These results could have been obtained by purely theoretical means. Soviet scientists, I. S. Shklovskiy and V. I. Krasovskiy, investigated the physical mechanism of the existance of the belts and the possible sources of the charged particles entering them. They arrived at the same conclusion as the Americans, but not by means of conducting explosions, but theoretically obtained these results, as they often say, "with the point of a pen". It is very probable that the possibility of obtaining these results by theoretical means caused the American scientists to make "Experiment Argus" secret. Similar tests could not remain secret. The fact of existance of high-altitude nuclear explosions is discovered by Soviet

and French investigators at the registering of briefly-periodic variations of the magnetic field. Lately, it has been reported that they were the same as those registered by the American scientists. All this indicates the impossibility of concealing nuclear weapons tests and the necessity of prohibiting them.

So, study of space with the aid of rockets and satellites established that the Earth is surrounded by large, dynamic radiation zones which are spread out for ten or more radii of the terrestrial globe. It further established that upon the ultimate penetration into outer space, beyond the limits of the external radiation zone, the intensity of cosmic radiation becomes comparatively slight. This, it stands to reason, is during a quiescent state of the Sun. During the flashes on the Sun large clouds of plasma (completely ionized gas) are thrown off into interplanetary space. Usually this is also accompanied by an increase in the intensity of cosmic radiation.

The magnetic field of the Earth. In the previous section it was pointed out that the magnetic field of the Earth is the original cause of the existance of the radiation belts of the Earth. This means that there must be materials for studying the zones of radiation and information on the magnetic field of the Earth at long distances from its surface.

It is known that magnetometers were installed on the third Soviet artificial satellite and on Soviet space rockets. The magnetometer on the third satellite permitted the obtainment of certain data on the "geography of the magnetic field" at altitudes from 230 km to 1800 km in the belt of latitudes, encompassed by the orbit of the satellite. This data can be compared with materials of ground investigations. It then serves as a basis for calculating the occurence depths of the sources causing constant abnormalities of the magnetic field of the Earth.

Not far into the center of the European portion of our country, the working of one of the richest iron ore bassins in the world has started -- the Kursk magnetic anomaly. It is a gigantic, natural storehouse of iron ore. The metal ex-

tracted from it is converted into machines, steel constructions, and railroad bands, takes part in the ulterior industrial development of the country and in carrying out the seven-year plan.

The Kursk magnetic anomaly is not the only one in the Union. In the east of the country there is a gigantic anomaly, where the arrow of a compass freakishly refuses to indicate the precise direction in the northern magnetic pole. In so far as the anomaly is stipulated, as a rule, with deposits of magnetic minerals, the question arises, won't the East-Siberian magnetic anomaly become the new metallurgical center of the country in the near future.

In order to obtain the answer it is not necessary to conduct deep drilling in the territories encompassed by the anomalies. The investigations conducted with the aid of the third Soviet satellite indicated that the deviation of the magnetic field at altitudes several hundreds of kilometers above the surface of the Earth differs very much from what was theoretically computed. This can be caused only by extremely powerful sources located at a very great depth.

Apart from constant anomalies, there are also periodic, brief variation of the magnetic field of the Earth. It was proposed that their existance is explained by current systems in the upper atmosphere. This had to be verified.

The results of the investigations with the aid of the third Soviet satellite provide a sufficient basis to assume that periodic variations of the magnetic field are stipulated by current systems in the area of the principle maximum of the ionosphere.

The magnetometer installed on the third Soviet satellite could register the intensity of the magnetic field at any geographic latitude and at any correction of the satellite. It permitted the detection and orientation of the satellite and its position at any moment in relation to the direction of the magnetic power lines. The position of the satellite at any moment in relation to its motion and the motion of the Sun etc. could be computed. This had important significance for a num-

ber of investigations.

What is still the most interesting object of the magnetometric investigations? The size and variability of the magnetic field at distances from the Earth corresponding to the radiation zones of the Earth. This interest is stipulated not only by the fact that the Earth's magnetic field is a trap for charged particles, but by magnetic effects which can be stipulated by the motion of the charged particles in the radiation belts of the Earth.

In connection with the necessity of measuring the magnetic field of the Moon, a magnetometer much more sensitive than the one installed on the third Soviet satellite was placed on the first Soviet space rocket. This led to a variation in the band of measurements: the maximum values of the Earth's magnetic field, which could have been measured by it, corresponded to the distance from the center of the Earth, equal to approximately 14,700 km. An even more sensitive magnetometer on the second Soviet space rocket started to measure the Earth's magnetic field at a distance of about 18,000 km from its center.

Consequently, the measurement of the Earth's magnetic field, accomplished with space rockets, encompasses only the external zone of the Earth's radiation belt, differing in its "inconsistent character".

It was established that the measured values of the magnetic field strongly differ to a small extent from the theoretically calculated ones, computed in a range from the initial point of measuring (14,700 km for the first Soviet space rocket and 18,000 km for the second Soviet space rocket) to distances of approximately 23,000 km from the center of the Earth. The congruence is sufficiently good at large distances.

Deviations of the measured magnetic field and the theoretically calculated one change with the passage of time. The magnetometer of the second Soviet space rocket registered a smaller deviation than the magnetometer of the first Soviet space rocket. It was also discovered that the deviation maximum of the magnetic field

from the calculated field is located somewhat closer to the surface of the Earth than the concentration maximum of trapped particles in the external radiation zone of the Earth.

The largest intensity of radiation is located closest to the Earth when a magnetic storm which had been preceeded by the intrusion of corpuscles is stronger. In comparing the intensity of radiation with the deviations of the actual magnetic field from the calculated field, the scientists obtained a basis for assuming that the external zone of radiation plays the role of an unusual "accumulator" of the charged particles of solar origin. This "accumulator" is filled with charged particles during magnetic disturbances and gradually loses them in the periods between such disturbances. This conclusion coincides well with the fact that the aurora polaris takes place regularily, not only on the days of magnetic disturbances.

It is proposed that the extra-ionospheric zonal current systems are the physical cause which was stipulated by the abnormality of the magnetic field in the external zone. In consideration of the character of the motion of the charged particles in the magnetic trap, it follows to consider the drift of charged particles into the magnetic field to be the only reason for such a type of current. In the drift, the positive particles are transfered to the west and the negative ones to the east.

The supply of electrons in the creation of the magnetic field, as the calculations indicate, cannot be large.

Soviet scientists propose that the natural magnetism of the external zone can be explained solely by drift currents of protons and positive ions.

But protons with energy on the order of several tens of electronovolts are still not discovered experimentally in the external zone. Does this mean that the proposal is erroneous? No, constant observations of hydrogen lines in the aurora polaris spectrum indicate the presence of protons.

The presence of two areas of deviations of the magnetic field from the calculated one, registered by the magnetometers of the first Soviet space ship (one area at a distance of 23,000 km; the second 25,000 km from the center of the Earth), N. V. Pushkov explained as the result of two concentration maximums of protons. The first of them was formed during a large magnetic storm on 3--6 December 1958, and the second during two moderate magnetic storms, which were observed from 12 through 20 December 1958 (a rocket, as we know, was launched on 2 January 1959).

The Sun controls the motion of the upper atmosphere. The study of the upper atmosphere was the first task of the investigations with the aid of rockets and artificial satellites. The fact that in a statement of the results obtained in the booklet, the atmosphere, it turned out the third place, is not at all explained by the disregard to the problem of the atmosphere or the insufficiency of the results obtained. The author's desire is to have the previous sections serve as explanations for the following ones. In particular, an understanding of the phenomena and processes, discovered in the upper layers of the atmosphere, requires a presentation on the radiation zones of the Earth and its magnetic field.

Measurement of the density of the atmosphere up to approximately 160 km cannot be accomplished with satellites.

If measurements can be made lower than 30--40 km with radio-sounds, then in the interval of altitudes from 40 to 160 km the natural direct method of investigating the density of the atmosphere is rocket sounding. These measurements were also mainly accomplished by the Soviet Union and the USA with rockets in various geographical latitudes during the IGY. The data obtained conforms well and indicates the measurement of the density of the atmosphere from day to night and from summer to winter. It also reports on the latitudinal variations of the density of the atmosphere at great altitudes.

As a result of the rocket sounding we succeeded in establishing how the temperature of the atmosphere is distributed according to altitude for various seasons

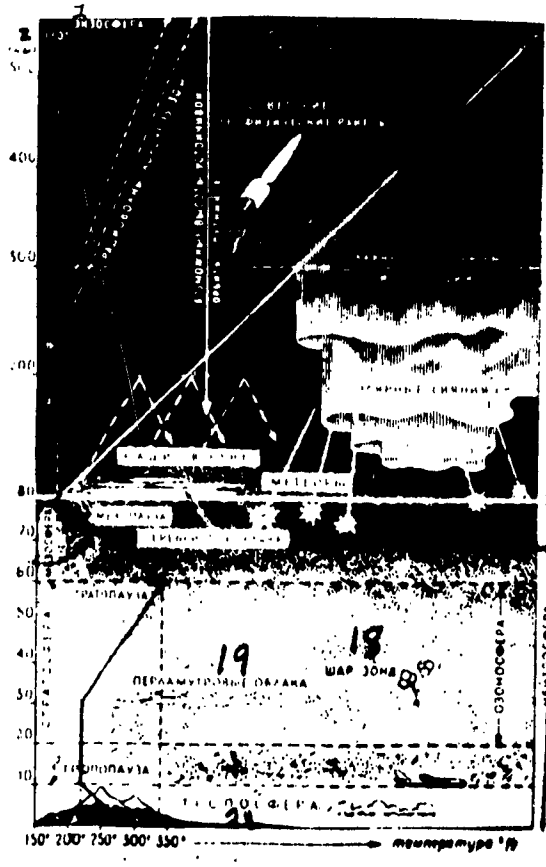
and latitudes. The wind velocity for a number of altitudes and the ion and gas composition of the atmosphere was determined.

One of the most important results of this entire section of investigations is the discovery of the dynamicness of the upper stratosphere and its lower layers; the detection of winds of very high velocity, significant measurements of all the characteristics of the atmosphere both the regular, as well as, possibly, the random. The diffusion division of argon and molecular nitrogen at altitudes higher than 110 km was discovered. It takes place under the action of gravitation due to the difference of the molecular weights of these gases.

See attached page 67a for Diagram

Diagram of the Structure of Earth's Atmosphere.

The permanently mobile, gigantic atmospheric ocean only recently became accessible for studying its nature by man. A more sufficiently clear explanation has still not been obtained and there is still more to do. But already after the ten years when Earth's atmosphere started to be studied with indirect ground methods, radiosounds, aircraft, much important data was obtained on its structure and motion. The greater amount of information on the structure and dynamicness of the atmosphere in the last few years due to rockets and artificial satellites is incomparable. (Key on next page)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ОЗОНОСФЕРА
ТЕРМОСФЕРА
ШАР ЗОНД
150° 200° 250° 300° 350°

Diagram

KEY TO "Diagram of the Structure of the Earth's Atmosphere".

1. Exosphere.
2. Soviet geophysical rockets.
3. Radiowaves shorter than 15--30 m.
4. Possible altitudes of stable orbit of satellites.
5. Thermosphere.
6. Ionosphere.
7. Prime maximum of ionization.
8. Aurora polaris.
9. Radiowaves.
10. Meteors.
11. Mesosphere.
12. Mesopause.
13. Stratosphere.
14. Stratopause.
15. Silver clouds.
16. Ozonosphere.
17. Neutrosphere.
18. Sounding balloons.
19. Nacreous clouds.
20. Tropopause.
21. Troposphere.
22. Temperature °C.

With the aid of satellites the density of the upper atmosphere was determined by means of measurements and observations of the deceleration of the satellites and registrations of the variation in the period of their revolution around the Earth.

The variation in the period of revolution of the satellite occurs because in decelerating it loses part of its energy and transfers to a more narrow orbit. This leads to a decrease in the length of the path and to an increase in its velocity. Since the density of the atmosphere falls very quickly with altitude, determination of the density on the basis of deceleration in the course of one revolution could be related to a lower point of the orbit, perigee. But does it then follow to think that the variations in the density with the aid of each satellite are calculated for one point on the surface of the Earth or, at least, could be related to one strictly determined geographical latitude?

This, of course, is not so. Perigee is gradually shifted along the orbit and as if rotates along it around the Earth. That is why with the aid of a satellite the density of the atmosphere can be measured in any hemisphere in a range of latitudes equal to the incidence of its orbit. The altitude at which the density can be determined remains equal to the altitude of perigee and, consequently, decreases very slowly in the course of time.

During the IGY the density of the atmosphere was determined with the aid of several satellites with various values of perigee, from 187 km to 650 km, and sometimes up to 1500 km.

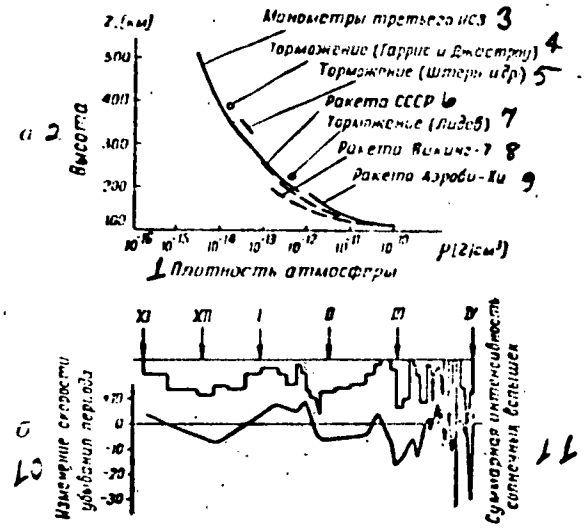
Instruments for measuring the pressure of the atmosphere were installed on the third Soviet satellite. This permitted the accomplishment of measurements in any point of orbit.

The data obtained indicates that the density of the atmosphere is significantly higher than was proposed earlier on the basis of certain theoretical premises and the first results obtained with the aid of rockets. It was explained that the exosphere (the external part of the Earth's atmosphere) does not extend for a thousand kilometers, but up to 2--3 thousand km.

The density of the atmosphere determined with the aid of satellites is presented in the table.

Altitude	200	250	300	500	700
Density at- mosphere, g/cm^3	$8.63 \cdot 10^{-13}$	$1.9 \cdot 10^{-13}$	$6.27 \cdot 10^{-14}$	$6 \cdot 10^{-15}$	$7 \cdot 10^{-16}$

With the aid of rockets and satellites it was discovered that the density of the atmosphere variates from day to night and from season to season; also registered was a decrease in the density of the atmosphere with a decrease in the geogrephical latitude of the place. A comparison of the variations in density of the atmosphere, obtained after observations of the deceleration of the satellites, with solar activity provided a clear statistical connection. It was noted that the variation in density of the atmosphere has a tendency to repeat with a period in 27 days. This corresponds to the period of revolution of the equatorial areas of the Sun around the axis (relative to the Earth). It was also discovered that the disorderly deviations in the density of the atmosphere are proportional to the variations in radio emission of the Sun from a wave length of about 10 cm, which characterizes the surface activity of the Sun.



Variation in the density of the atmosphere with altitude (a) and variation in density of the atmosphere depending on solar activity (b).
The density of the atmosphere, determined according to the period of the satellites revolution around the Earth as a result of its deceleration by the atmosphere is changed in close accordance with solar activity.
Key to graphs on p. 71.

Key to graphs on page 70:

1. Density of the atmosphere.
2. Altitude.
3. Manometers of third artificial earth satellite.
4. Deceleration (Harris and Jastro).
5. Deceleration (Stern et al.).
6. USSR rocket.
7. Deceleration (Lidov).
8. Viking-7 rocket.
9. Aerobee-Hi rocket.
10. Variation in velocity of decrease in period.
11. Total intensity of solar flashes.

In separate cases (after large flashes on the Sun) it was noted that the change in density of the atmosphere (registered with the aid of the third satellite)takes place synchronously with the attainment of the environs of the Earth with corpuscular flows, but not together with the flash, and with a delay of approximately one 24-hour period (the time which is required for the environs of the Earth to attain a flow of corpuscles) and simultaneously with the beginning of a magnetic storm, caused by the corpuscular flows.

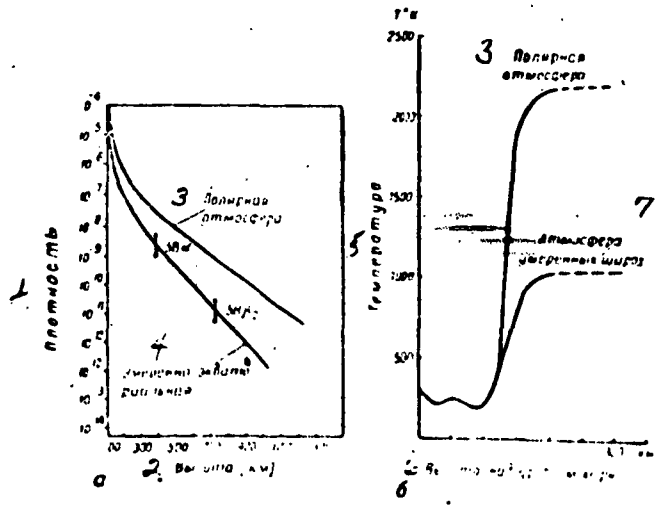
The length of the existance of the third Soviet artificial Earth satellite is proof of the lasting influence of solar activity on the state of the upper atmosphere. The satellite traveled almost half a year more than it was determined by the initial calculation. An error in calculation? No, contemporary computation media exclude the possibility of such a clumsy mistake. The reason is in the fact that in the initial calculation of the length of existance of the satellite data on the density of the atmosphere at the end of 1957 to the beginning of 1958 was utilized. At this time there was a maximum of solar activity. With its decrease at the end of 1958, 1959 and the beginning of 1960, the density of the upper atmosphere and

resistance to motion was reduced, and the life-time of the satellite was increased.

There are still certain facts determined by rockets which are necessary for constructing a hypothesis concerning the mechanism of solar action on the upper atmosphere.

Above all, a sharp difference in the densities of air at altitudes higher than 100 km is noted in the poler and moderate latitudes. The density of the polar atmosphere turned out to be approximately six times higher. It is true, measurements of the density of the atmosphere in moderate latitudes, with which a comparison was made, pertained to 1951, when there was a minimum of an eleven year cycle of solar activity, and measurements in the polar latitudes pertained to 1957. But it followed to expect that the difference would remain greater upon simultaneous measurment.

It was also discovered that the determination of the density of the atmosphere, performed by observations of the motion of the American satellites, with small angles of orbital incline towards the equatorial plane (and not having fallen in its motion on orbit in the polar areas), did not provide latitudinal measurement of atmospheric density and such a strong connection of it with solar activity, which was obtained by observations of the motion of Soviet satellites.



(Caption and key to figures on page 73)

Caption to figures on page 72: Density (a) and temperature (b) of the upper atmosphere in polar and moderately equatorial latitudes.

With the aid of rockets and satellites substantial differences in the density and temperature of the atmosphere of the polar and moderate zones are established. Together with the dependence of the variation of the period of motion of the satellites (on strongly inclined orbits) on solar activity, this offers a basis to propose that the polar atmosphere in its upper layers is heated by solar corpuscles, trapped by the Earth's magnetic field and directed by it to polar areas.

Key to figures on page 72:

1. Density.
2. Altitude /km/.
3. Polar atmosphere.
4. Moderately equatorial.
5. Temperature.
6. Altitude above sea level.
7. Atmosphere of moderate latitudes.

These variations in density can be explained only by heating of the atmosphere. Its temperature was determined by direct methods in rocket sounding up to comparatively low altitudes: approximately 100 km. Higher than these altitudes determination of temperature took place not by direct methods, but according to that variation in density, which was mentioned above. Thus, as a result of measurements of the temperature, it was discovered that it is significantly higher than was proposed earlier, and in the polar latitudes reaches altitudes of 200 km 2000° C and greater.

The higher density and temperature of the upper atmosphere than was proposed earlier brings up a question: what are the sources of such warming of the atmosphere?

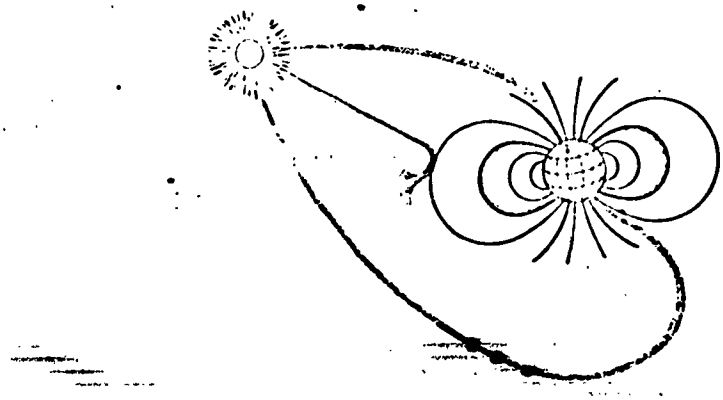
It was proposed earlier that warming of the atmosphere occurs exclusively due to the shortwave, ultraviolet, radiation of the Sun. But it turned out that it was insufficient for providing such warming, which is observed in reality. Various proposals were made, for example, the warming takes place because of infrasonic oscillations, which may be caused by swelling of the sea, accretion[1] of cosmic dust

and micrometeors etc.

All these hypotheses upon careful examination turned out to be incompetent for explaining the physical mechanism of warming (as, for example, warming by infrasonic waves) or did not explain any rules in the change in density.

The hypothesis concerning the mechanism of warming the atmosphere with solar corpuscles, which have fallen into a magnetic trap of the Earth and can be focused by the magnetic field to the polar areas of the atmosphere is the most universal and probable hypothesis. This hypothesis permits an explanation of a rule in the changes in the density of the atmosphere and their correspondance with such phenomenom of nature as the aurora polaris.

Consequently, it is now difficult to indicate the construction of a single standard model of the atmosphere for all belts of the Earth. They are different for the polar zones and moderate latitudes. There is still no data concerning the influence of warming the upper atmosphere on its lower layers and the development of meteorological processes in the troposphere.



Possible paths of charged particles from the Sun to the Earth (according to Stormer and Bennet).

Theoretically the mechanism of capturing and holding of charged particles by a magnetic field was established long ago, when scientists first tried to explain the aurora polaris.

1 Accretion -- capture of matter from outerspace by a field of gravitation.

Exploration of the atmosphere with rockets and satellites was done not only for studying its heat process. For an explanation of atmospheric warming it is necessary to know its ion and molecular composition and to study the electron concentration in the ionosphere.

These explorations were made by several methods. One of them was observation of the propagation of radio signals from the first Soviet satellites. What is the essence of this method? It is the bending of the path of propagation of radio waves of determined frequencies and a radio beam upon its passage through the ionosphere.

Such a method of exploration permits determination of only the concentration of electrons in the ionosphere. This is explained by the fact that "heavy" ions more than a thousand times weaker influence the character of propagation of radio waves, than the "lighter" electrons. The operating frequencies of the radio transmitters (20 and 40 cps) of the Soviet satellites were selected namely to receive ionospheric radiation in observations of the propagation of radio waves.

The operating frequencies of the American satellites were approximately 108 cps. In observing their propagation it was impossible to conduct a study of the ionosphere. The radio waves of these frequencies penetrate through the ionosphere freely, not changing the direction of its propagation. This offered the possibility of observing the satellites with radio technical media. The difficulty of precise optical tracking of small satellites is obvious and led the American scientists to the selection of such operating frequencies.

In the process of the radio observations of the Soviet satellites with the purpose of studying the ionosphere there were cases of super-remote registrations of the satellite's signals and even a "circular echo" (propagation of radio waves around the globe). This sudden result indicates the presence of unusual waveguides in the ionosphere.

Studying the ionosphere on the basis of observations of the propagation of radio signals can be accomplished by several methods. One of the most simple and

effective of them is registration of the moments of radio rise and radio fall. It permits the obtainment of a concentration of electrons in the ionosphere higher than the prime maximum of ionization which is perfectly inaccessible for a study with ground methods of radio measurements. Due to the radio beam bending upon passage through the ionosphere the moments of radio rise and radio fall will not coincide with the moments of optical rise and fall. The greater the difference in time between them, the higher, obviously, the concentration of electrons on the path of passage of the radio beam between the satellite and the surface of the Earth. It is natural that such a method does not provide a sufficient basis for a judgement concerning the structure of the ionosphere, and this is very important.

Measurement of the electron concentration in the ionosphere was also conducted in the launchings of Soviet geophysical rockets by means of ultrashortwave dispersion interferometers. This method, proposed by L. I. Mandelstam and N. D. Papalexi, permitted the obtainment of a sufficiently accurate change in electron concentration with an increase in altitude.

By means of similar methods, a study of the ionosphere was made by foreign investigators. A great deal of work in the study of the ionosphere (by means of observations of the propagation of radio signals from Soviet artificial satellites) was done in England. The usually cloudy sky of this country prevents optical observations of satellites. The high development of radio-technical means of observing the motion of satellites aided in the broad conductance of ionospheric investigations by means of tracking the propagation of radio signals from artificial satellites.

What are the results of studying the electron concentration in the ionosphere? It can be said that clearly expressed ionospheric layers are absent. There are several peaks on the total curve of the increase in electron concentration (from zero and to the prime maximum of ionization).

The character of lowering the electron concentration (higher than prime maximum) is very even. The electron concentration decreases five to six times slower than it increases in a layer lower ten prime maximum. Then it is gradually decreased to a concentration of electrons of an interplanetary ionized medium. This is confirmed by rocket soundings and satellite investigations of the ionosphere.

However, the mere knowledge of electron concentration in the ionosphere is insufficient; it is necessary to determine the concentration of positive ions. The ionosphere, as a whole, is electrically neutral. Therefore, the quantity of positive ions must correspond to the total of electrons and negative ions.

Positive ions were registered on the third artificial satellite. It carried a special apparatus with two ion catchers. The spherical collector of these catchers had a negative charge, which collects positive particles and repels the negative particles. The ion current flows to the collector of the catcher and determines the concentration of positive ions in the external medium.

The satellite's potential relative to the external medium can also be determined with ion catchers. This in turn offers the possibility of making a judgement concerning the effective temperature of electrons, characterizing the velocity of their motion. It turned out that the effective temperature of electrons in the ionosphere is much higher than the temperature of neutral particles and ions. This new result requires further study and a physical explanation.

A method of collecting air samples by means of special balloons was widely utilized for determining the composition of the atmosphere during rocket sounding. The air was carefully pumped from them on the ground. At a given altitude the ballons were opened and after taking samples they were closed. What is the complexity of this method? It is difficult to create a deep vacuum in balloons; an influence of the gases leaving the rocket during flight on the results of the investigations is possible; it is complicated to analyze small quantities of matter. An insufficiency of the method also lies in the fact that it permits the obtainment of only

the chemical, and not the ion composition of the atmosphere. In an isolated volume of a balloon, particles of the atmosphere cannot be found in a state of photochemical equilibrium, as in the upper atmosphere. Therefore, an instrument was created, which could determine the ion composition of the atmosphere immediately. Such an instrument, a radiofrequency mass-spectrometer, was installed on the third Soviet satellite. This instrument is more preferable on a satellite than on a rocket. After several days the satellite's gas liberation ceases, and the results of the measurements are sufficiently accurate (if you do not consider the interaction of gas particles with the sides of the instrument).

The mass-spectrometer, by means of an electrical or magnetic field, separates and divides ions according to mass. When electrical fields of high frequency are utilized for separation, the mass-spectrometer is said to be radiofrequency.

The diffusion division of argon and molecular nitrogen was registered namely with the aid of such instruments during rocket investigations. What is the shortcoming of such an instrument? The fact that it is difficult to investigate molecular composition with its help.

Measurements of ion composition, made on the third satellite in the 225 km to 980 km range of altitudes, indicated that in day-time positive ions of atomic oxygen prevail at these altitudes. In addition to those ions, positive ions with mass number 14 were registered, which could be identified with ions of atomic nitrogen, positive ions of atomic oxygen isotope with mass number 18, positive ions of molecular nitrogen, positive ions of nitrogen oxide and positive ions of molecular oxygen were also registered.

The results obtained indicate that the ion composition of the upper atmosphere changes substantially depending on altitude. The percent (in relation to ions of atomic oxygen) content of heavy molecular ions of molecular oxygen, nitric oxide and molecular nitrogen falls with an increase in altitude. It is interesting to note that the relative content of these ions falls the fastest in the 225 km to

270 km altitude interval, after which the decrease becomes slower. The content of ions of molecular oxygen at altitudes above 400 km is more than a thousand times less than the ions of atomic oxygen. The content of ions of nitric oxide becomes a thousand times less at altitudes above 500 km. The relative quantity of ions of atomic nitrogen increases with an increase in altitude.

It was further discovered that the ion composition depends on the geogrephical latitude. Therefore, the relative content of ions of atomic nitrogen at altitudes from 225 to 350 km increases significantly upon transfer from the 30°-50° area of north latitudes to the 55°-65° north latitudes. The relative content of ions of molecular nitrogen, molecular oxygen and nitric oxide also increases in these latitudes in comparison to more southern latitudes.

Measurements of electron and ion concentrations, conducted a different times, indicate an insignificant variability in them with the course of time. One can assume that many of these variations are quite rapid and create the known difficulties in radio communications (in radio-telephone conditions) with satellites moving higher than prime maximum.

Right now there is still no exhaustive explanation of the various peculsrities in the structure and life of the ionosphere. The data obtained in ionospheric measurements is too fragmental and incomplete. Very little is known about the active factors which could influence ionization and its variation in time (ultraviolet and X-ray emissions of the Sun, corpuscular radiation of the Sun, cosmic rays and micrometeors). One can only propose that the Sun (the role of which in the motion of the upper atmosphere can be considered as proof) seems to greatly influence its electrical characteristics. They can be part of the total action of the Sun on the atmosphere.

Materials of interstellar space. "Absolute vacuum" and "absolute cold" are incompatible expressions, but are used quite often recently for the characteristic of interplanetary space, especially in science-fiction and popular-science literature.

It is now known that besides the large number of meteors lighting up the nocturnal sky with firey streaks, there is a mass of small meteor particles and cosmic dust, filling interplanetary space and penetrating into the Earth's atmosphere.

Fine and porous in structure, the particles can penetrate into the atmosphere without changing physical qualities. This created the known premises for studying the particles on the basis of air contamination, sedimentary rocks of deep seas etc. Such investigations together with ground observations of meteors (bright traces of the combustion of meteors in the upper atmosphere) confirmed to a large extent the proposals concerning the size of the masses of meteor particles and their structure.

But together with that, ground methods of investigations could not provide a complete possibility for studying solid matter of interplanetary spaces. For an evaluation of the total amount of meteor particles falling to the Earth, their mass and energy, it was necessary to bring instruments beyond the ranges of the atmosphere. For automatic exploratory rockets and more so for manned flight, the meteors moving with colossal speeds could present a tremendous danger and a before-hand evaluation should take place.

What does the meteor danger consist of in its most immediate form? In the possibilities of damaging the walls of the compartment or cabin of a space-ship, which leads to instant depressurization, cessation of operation of apparatus or the necessity of fast correction of the damage.

Another form of meteor danger is micrometeor erosion. It is the gradual abrasion of the surface layer of metals under the action of fine dust particles borne by cosmic speeds, a danger to the surfaces of solar batteries and optics. The small particles shot out by a sand-blasting apperatus affect a metallic or granite surface similar to the action of erosion. The mechanical damage caused by erosion is not great and could be disregarded. But it can lead the space ship to destruction of the heat conditions which in turn can strongly influence the operation conditions of the instruments and astronauts.

In interplanetary space where the density of the surrounding medium is low, the temperature of bodies is determined by radiation characteristics, i.e. the ability of a surface to emit and absorb heat rays, and the internal heat supply due to the operation of the apparatus and the viability of the organisms. Therefore, variation in the radiation characteristics is extremely important.

The geophysical effects of heating the atmosphere, already mentioned above, may pertain to the meteor material concerned.

Large meteors are rarely encountered. The extremely small dust particles, micrometeors, present a basic danger to space flights.

Therefore, in the preparation of the very first experiments on rockets and satellites, the Soviet and American investigators began to develope an apparatus for registering the strikes of micrometeor particles.

One of the first methods of studying meteor particles (applied by the Americans in the launchings of the famous "V-2" rockets soon after the end of the war) was the acoustical method. Special microphones registered strikes of meteors around the hull of the rocket. They permitted the obtainment of data for a very large surface, but could not, naturally, provide distribution of the particles according to mass and energy, since the acoustical effect, to a considerable extent, was determined by the characteristics of that part of the construction where the strike took place.

Scientists proposed the creation of various devices. One of them was composed of grids with thin wires, and a judgement can be made concerning the size and frequency of the micrometeor impact on the basis of breaks in the wire. Another device had the form of a package composed of extremely thin conductors, which must gradually wear out under the action of meteor dust, changing the total electrical resistance of the package (this was also a sign of meteor erosion). One more device had a photosensitive element covered by an opaque emulsion. Micrometeor damage to this emulsion created the possibility of a photoelectric effect and regis-

tration of meteor matter.

Piezo-devices were widely applied by Soviet scientists in meteor investigations. The property of certain crystals (for example, ammonium phosphate) is used in these devices to provide a difference in potentials on linings upon a meteor strike around a plate rigidly resting on a system composed of several piezo-elements. The advantage of such a system is in the invariability of the characteristics of the device over a long period of time, until it is destroyed.

Such a system of registration permits the measurement of the frequency and energy of meteor strikes. Calculations indicate that the devices permit the measurement of the energy of meteor particles having masses from 10^{-9} g and more.

The average frequency of meteor strikes, registered by the third satellite (Sputnik III), is approximately $1.7 \cdot 10^{-3}$ square meters per second. The results obtained by Sputnik III also indicate that the frequency of micrometeor collisions with the surface of the satellite rarely increased with time: devices registered the magnitude of a number of strikes. So, for example, on 15 May 1958 the magnitude reached 4--11 strikes per second in one square meter. It was explained by the passage of the satellite through a meteor shower.

What does this conclusion follow from? From the fact that in variation of a number of strikes there is a periodicity coinciding with the periodicity of the revolution of the satellite relative to the center of gravity. Consequently, the majority of meteor particles had one and the same direction of motion. Theoretical calculations indicate that if the particles emerge at an average speed of 40 km/sec., then after a time strikes were registered around the devices of particles having masses from $8 \cdot 10^{-9}$ to $2.65 \cdot 10^{-8}$g and energies of about 10^4--10^5 erg.

Devices for registering micrometeors were installed on the three Soviet space rockets. An experiment on the first space rocket provided a comparatively small number of strikes, insufficient for delivering them to telemetry (gathered data). Accumulation of data did not take place on the second space rocket and it was de-

livered immediately.

The results indicate a frequency of $9 \cdot 10^{-5}$ strikes per second in 1 m^2 for particles having masses of $6 \cdot 10^{-9}$--$1.5 \cdot 10^{-8}$ g it is less than $5 \cdot 10^{-5}$ strikes per second in 1 m^2. The devices placed on the automatic interplanetary station (AIS) indicated an average of $3 \cdot 10^{-3}$ strikes per second in 1 m^2.

There was a report in the press that as a result of the experiments conducted on the satellites there is a basis to assume that around the Earth at comperatively low altitudes (approximately one hundred kilometers) there exists a ring composed of micrometeors. The existance of this unusual ring was mentioned earlier, emerging from theoretical considerations.

There is a report that the general results of studying meteors with satellites led to the conclusion that the Earth is surrounded by an unusual micrometeor area, extending up to altitudes of approximately one hundred thousand kilometers. Concentration of particles in it is relatively small, but it is immeasurably higher than the concentration of particles in interplanetary space. An American astronomer, F. Whipple, proposes that these particles obviously have a lunar origination.

There is a basis to assume that the AIS "registered" the fall of meteors of larger sizes than any of the others colliding with previous Soviet rockets and satellites. Its unexpected disorder and cessation of information transmission can only be explained by the meteor damage to it. Such an explanation is more plausible, since at this time the Earth passed through one of the meteor showers. The total magnitude of the frequency of strikes of meteors, as it follows from the data presented above, was registered by AIS devices.

This is not a solitary case. The American satellite, "Explorer-III", was damaged upon the passage of the Aquarids meteor shower at the beginning of May 1958. It is characteristic that upon this at first the device registered the fall of a large meteor, then one after the other the radio transmitters went out of order. Does this mean that the meteor danger is that great?

In spite of these two cases, there is no basis to consider it to be great. The lengthy work of other satellites and space rockets, the total number of launchings of which is more than ten, the results of registering meteors with special equipment and the length of operation of the solar batteries provides a basis to assume that meteor danger is not serious for piercing the hull and eroding it. The instances with the AIS and "Explorer-III" is a rather disappointing accident than an inevitable rule...

Not only meteors and cosmic dust fill interplanetary space. Right up to the beginning of direct investigations the proposal existed that space contains interplanetary gas. The results of measuring the polarization of "zodiacal light" (a weak illumination of the sky in the ecliptics plane, which can be observed in the south latitudes and characterized by the diffusion of solar light by extremely small particles of matter) led some investigators to a conclusion concerning the fact that interplanetary space is filled with electrons. Their density in the region of the Earth consists of approximately 600--1000 $1/cm^3$. Since the medium as a whole is neutral, there must also be positive particles with the same concentration contained in it.

Other experimental arguements in the use of the existance of interplanetary gas were the "whistling atmospherics" (lowfrequency electromagnetic oscillations, originating as a result of lightening discharges and spreading along the magnetic power lines of the Earth's magnetic field). The concentration of electrons determined on the basis of these atmospherics in interplanetary space (in this manner one could determine it up to distances of 50--60 thousand km from the surface of the Earth) is equal to approximately 1000 $1/cm^3$.

Before the investigators stood the task of verifying the indicated conclusions, explaining whether or not these particles belong to the corpuscular flow continuously being discharged by the Sun. This could only be done with the aid of space rockets.

One can distinguish the stationary gas composing interplanetary space (its particles have energy of approximately 1 ev) from the flows of solar corpuscles (large energy) by means of dividing the registered particles according to energy. Distribution of particles with high energy can be attained, for example, by means of an installation of corresponding screens, calculated on the passage of particles having energy not lower than the determined limit through them.

On the first Soviet space rocket this division was attained by means of the simultaneous utilization of four proton catchers. Two of them had a positive potential on the outer screens. Particles of stationary gas could not have fallen into these catchers. They only registered protons of corpuscular flows.

The two remaining catchers registered summary proton currents, caused by both stationary protons and protons of solar corpuscular radiation. In the experiment system the possibility of precise calculation of the electrical potential of the hull relative to the medium was not examined, therefore the results obtained bear an appraisable character.

This data indicates that interplanetary ionized gas exists. Concentration of positively charged particles of gas at an altitude of 1500 km in a non-illuminated area of the atmosphere is approximately 1000 $1/cm^3$. At an altitude of 2000 km in the same conditions, concentration is half as much. Higher it maintains almost a constant value up to 21--22 thousand km. At a distance of 110--150 km the concentration of particles is lowered to 300--400 $1/cm^3$.

The discovery of interplanetary gas during the rocket experiments occured unexpectedly, while photographing the celestial sphere in ultraviolet rays.

We know that in order to study the composition of stars and nebulae, and also the processes going on in them, it is very important to conduct spectrometric investigations in ultraviolet rays, for which the Earth's atmosphere is not transparent. These experiments were made on rockets. Photography of the nocturnal sky from high altitudes indicated a great brilliance in the areas opposite the Sun.

This radiation can only be explained by the presence of hydrogen in the interplanetary medium, in the radiation line of which photographs were taken.

A natural satellite of our planet. The Soviet space rockets (launched in 1959), in addition to studying interplanet space and space near the earth, transmitted information to Earth concerning our nearby cosmic neighbor.

In the investigations of the Moon Soviet rocketry for a long period of time is maintaining not only priority, but a "monopoly". American scientists launched many Earth satellites, but were not able to approach a study of the Moon. The American rocket, which was successfully launched in the direction of the Moon ("Pioneer-IV"), passed it at a distance of 60 thousand km.

The first Soviet rocket investigated the vicinity of the Moon: it went along a given trajectory to a distance of 5 thousand km from the surface of the Moon. The second rocket made a vertical cross section of the space near the Moon almost up to the surface of the Moon, having accomplished the first interplanetary flight in history. In honor of this outstanding occasion banners with the symbol of the country of socialism were placed on the surface of the Moon.

The most important result, obtained in this launching is an experimentally established fact: the Moon has no significant magnetic field and formations similar to the Earth's radiation belts. They could not originate without magnetic traps. We succeeded also in discovering an increase in the concentration of ionized particles as you draw closer to the surface of the Moon. The ionosphere of the Moon is unusual and extremely rarefied in comparison to the Earth. Its discovery confirms the theoretical assumptions and those ground experiments (observation of radio stars), which indicated the presence of this atmosphere.

The third Soviet space rocket sent an automatic interplanetary station (AIS) into an exceptionally complicated spatial orbit.

This station, besides the ordinary investigations, had a special mission:

to photograph the opposite side of the Moon, which is invisible from the Earth and therefore was not completely studied to that time. We known that this mission was successfully accomplished.

With the aid of the special engines and photoelectrical apparatus, the station, on an orbit between the Sun and the Moon, accomplished orientation at first to the Sun, and then to the Moon and with the aid of two cameras, photographed the opposite side of the Moon from a distance of 60--70 thousand km. The photographs obtained were then processed under the complex conditions of space flight and transmitted to the Earth with the aid of a television installation.

In the photographs of the far side of the Moon there are considerably fewer "seas" and more elevated and mountainous regions than on the visible side. Two seas are clearly visible in the photographs: the "Sea of Moscow" with the "Bay of Astronauts" and the "Sea of Dreams". The courses of certain seas, visible from the Earth at the edge of the lunar disk, the "Soviet" Mountain Range, the "Tsiolkovskiy", "Lomonosov", "Joliot-Curie", "Mendeleyev", "Jules Verne", "Edison", "Kurchatov" craters and many others were photographed.

Altogether, on the far side of the Moon, by means of careful deciphering with a large degree of accuracy, 252 formations were discovered, out of them approximately 100 belong to the region of the visible side of the Moon. 190 details of the surface were discovered with less accuracy. 57 details were discovered with little accuracy -- only one sequence needs confirmation.

It follows to remark that the photography was done not under completely favorable conditions. The attempt to possibly photograph a large part of the surface of the far side of the Moon led to the selection of a moment when the entire far side was illuminated. The absence of side shadows concealed the relief of the terrain and made the illumination "flat".

Toward a dream. It is probable that man's first conscious glance into the

sky was connected with the dream of flying upwards, beyond the clouds, to the sparkling lights of the stars. For many centuries mankinds striving towards the stars and remote unknown worlds was developed and strengthened, but, like many other strivings, remained only a dream, beautiful and hopeless...

Means of ground communications were developed and the striving to utilize the air envelope of the planet for them was even greater. At first birds were imitated. Wings for gliding, then an air balloon carried by the wind, a non-maneuverable and sluggish dirigible and, finally, a motorized aerodynamic flight of man in an airplane.

Airplanes were quickly developed, striving to increase their speed and ceiling. But they could not become the means of flying to other planets and worlds.

Photograph of the Far Side of the Moon.
An automatic interplanetary station transmitted a large number of photographs of the far side of the Moon to the Earth, the side which cannot be observed from the Earth.

Only after the publication of K. E. Tsiolkovskiy's clear and realistic ideas, the developement of modern technology turned the dream of extraterrestrial flight at first to hope, and then to solid certainty. The reality of the task and the necessity of its profound solution compelled the investigators to ponder over all aspects of the problem, which could arise upon the taking of this step.

What physical conditions will man encounter in space? What will his psychological reaction be to this new situation? What measures are necessary for guaranteeing safety of the flight? What could be the possible consequences of such a flight? All these questions required an immediate solution.

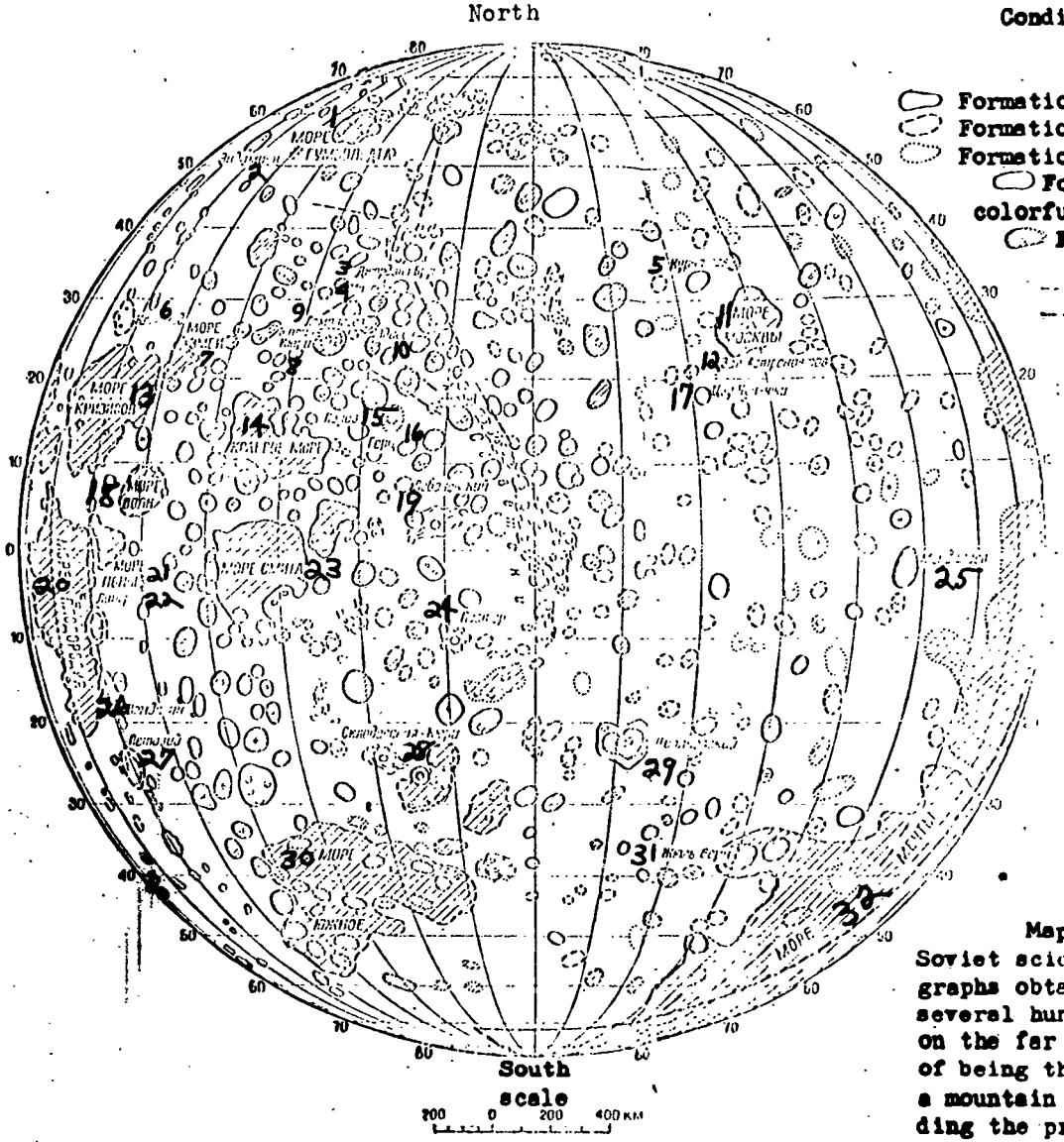
Experiments in baro- and thermo-chambers, artificially created on special installations -- "overloading" centrefuges, various psychological investigations under special conditions, simulation of weightlessness upon immersion in a liquid and the creation of momentary weightlessness in airplane flight along a specially calculated curve -- all these are stages in the way to the solution of specific elements of these problems.

But in ground experiments it is impossible to create prolonged weightlessness, impossible to estimate the influence of penetrating radiation on organisms of living matter upon leaving the limits of a dense atmosphere.

Therefore, with the appearance of sufficiently powerful rockets, the investigators immediatly went on to natural experiments. As always in the history of medicine, we turned to animals so as not to risk a human life. Dogs began to be sent into the upper atmosphere, paving man's ways to space.

Why dogs, especially? In the USA preference was given to mice, rats, monkeys...

The fact was that dogs easily undertake depression. Their physiology was studied very well by Soviet scientists, beginning with I. P. Pavlov. The facility of depression permitted us to place a portion of the dogs in a flight while "conscious", as monkeys in American experiments were found under narcosis.



Conditional Symbols

- Formations proved with clear outlines
- Formations with less clear outlines
- Formations whose outlines must be
- Formations more / filled in colorful than surrounding background
- Formations darker than background
- Light beams
- Border of visibility

Map of the Far Side of the Moon. Soviet scientists deciphered the photographs obtained from the AIS, which showed several hundreds of different formations on the far side of the Moon. On the right of being the first discoverers, they named a mountain range, "seas", craters, recording the priority of Soviet science and the names of many outstanding members of world science.

Key to the "Map of the Far Side of the Moon":

1. Humboldt's Sea.
2. Endymion.
3. Giordano Bruno.
4. Maxwell.
5. Kurchatov.
6. Cleomedes.
7. Mare Umbre (Sea of Shadows).
8. Joliot-Curie.
9. Lomonosov.
10. Edison.
11. Sea of Moscow.
12. Bay of Astronauts.
13. Mare Crisium (Sea of Crises).
14. Mare Marginis (Border Sea).
15. Popov.
16. Hertz.
17. Tsu Ch'ung chich.
18. Mare Undarum (Sea of Waves).
19. Lobachevskiy.
20. Mare Foecunditatis (Sea of Plenty).
21. Mare Spumans (Sea of Foam).
22. Langrenus.
23. Mare Smythii.
24. Paster.
25. Mendeleyev.
26. Vendelinus.
27. Petavius.
28. Sklodowska-Curie.
29. Tsiolkovskiy.
30. Mare Australe (Southern Sea).
31. Jules-Verne.
32. Sea of Dreams.

For a comparatively long time Soviet engineers have been studying high-altitude rockets and special containers carrying instruments and animals which were catapulted from the rockets and returned to Earth. Numerous experiments indicated that animals take overloading well, vibration and weightlessness during launchings up to an altitude up to several hundreds of kilometers. Many of them were sent up in rockets several times and felt splendid.

However all of these experiments were comparatively short: flight of the rocket upwards and its descent takes several tens of minutes. In order to explain the influence of a prolonged state of weightlessness, it was necessary to perform an experiment on an artificial earth satellite.

This was done on 3 November 1957, when the dog Layka began her flight on the satellite. She was fated to die: the satellite was not expected to return to the earth. But this death was not in vain. For a week, by means of numerous devices, Layka "spoke" on a telemetric channel concerning her state-of-being and the viability of organism under the unusual conditions of space flight.

It follows from this "conversation" that on the active portion, when a large overload occured, the dog's respiration rhythym and cardiac activity intensified. After the overloading ended, it gradually returned to normal. It also follows from this "conversation" that neither the overloading during orbital entry, nor the prolonged state of weightlessness hindered the flight into space.

Does this mean that the road to space was opened? Ofcourse not. Thousands of dangers, obvious and hidden, face man in space. The persistant work on the study of all the problems of space flight continued. Rocket launchings and tedious ground investigations were started anew.

Other work was going on at that time. Rockets were perfected which were capable of carrying more solid and heavier equipment, similar to future space ships, and new powerful rockets were tested which accurately reached an assigned point of the water surface in the water space of the Pacific Ocean.

GRAPHIC NOT REPRODUCIBLE

Layka in the Cabin of Sputnik II

Biological investigations occupied a large place from the very beginning in the complex of investigations with Soviet artificial earth satellites. Their purpose was to explain the influence of specific conditions of rocket and space flight on living organisms. It is necessary both for studying the possibility of the existance of organisms in conditions different from the earth, and for providing flight safety of man in outer space. Layka, the first space traveler, did not die in vain. The experiment on Spunik II permitted the obtainment of data on the possibility of the space flight of highly-organized living matter.

Finally, the first satellite ship was put into orbit around the earth. There was no living matter on it; neither animals, nor humans. They were replaced by a mannequin. This is explained by the fact that the program did not expect the ship to return to earth. Therefore, an experiment with a man was not possible. An experiment with animals could not offer anything new in comparison with what the launching of the satellite containing Layka provided.

A prolonged experiment on a large number of experimental animals was necessary with the required return to earth, in order to explain how an organism behaves in

conditions of prolonged space flight. What are the reactions of the flight conditions and their genetic influence? What is the degree of exposure of various organisms to the influence of specific conditions of space flight?

Namely such a "zoological garden" was put into orbit on 19 August 1960 on the second satellite ship. There were cages placed in its pressurized cabin containing two white laboratory rats, 15 black and 13 white laboratory mice. In the ejection contained of the ship were located two dogs (Belka and Strelka), a cage with 6 black and 6 white mice, several hundreds of insects (flies), two vessels containing plants (spiderworts), seeds of various kinds of onions, peas, wheat, maize and nigella, special vessels containing fungi (actinomycytes),uni-cellular algae (chlorella in liquid and solid feeding media). In 50 holders there were sealed ampoules containing bacterial cultures of intestinal bacilli, bacilli of butyric fermentation, ampoules with staphlococcus cultures, two varieties of phages, a solution of desoxyribonucleic acid (DNA), and also a culture of epitelial tumor cells of a human (Hel's cells) and small pieces of preserved skin of a human and a rabbit. In addition, in the container were located 4 automatic bioelements containing cultures of butyric fermentation bacilli, 2 bioelements in a special thermostat and 2 in an unheated container.

What was the point and purpose of each of these experiments?

The dogs must have "spoken" of their state-of-being at all stages of flight (at this time not only by means of pickups and in front of television cameras), and also of their status after returning. The black and white mice must have helped investigate the possibility of mutation changes. A large number of experimental animals created wide possibilities for obtaining statistically reliable, and not accidental results.

Fruit flies (drosophyla) were the usual objects of genetic investigations. Drosophylla chromosomes are large, and after ten years of their study it was established, in every sequence biochemical "embryos" of characteristics (genes) located

in them. Flies quickly develope and multiply; therefore, very soon after the experiment it is possible to obtain the first materials concerning the influence of cosmic radiations on the heridity of insects.

Belka and Strelka -- "passengers" of the second space ship. The experiment with Layka, as also numerous biological experiments on geophysical rockets, did not provide exclusive information. When one speaks of human life, a very careful and close check of the various aspects of the influence of flight conditions on the organism and safety is necessary. On the second space ship were two dogs, Belka and Strelka. Their condition was monitored by means of telemetric transmissions of information, television observation, and also by means of studying the viability of the organism after the return of the space ship to the earth.

Spiderwort is an interesting object for investigations. In its cells are six pairs of large and well-distinguished chromosomes. Any chromosome variations will be detected in the dividing bud cells. On the basis of these changes one can very precisely determine the dose of ionizing radiation. The spiderwort is as if a "living dosimeter".

Nucleic acids are substances of heredity. Their molecules can be called "naked genes" or "genes in freedom". The influence of radiation could cause variation in the structure of this acid, which can be detected by means of physical and chemical investigations. This division of the investigations must have indicated the

immediate mechanism of radiation action on an organism.

Penicillin is a very important drug. New types of hybrids are now exposed to radiation action. Bacilli is a convient object for radiation investigations, and, maybe, not without practicelly important consequences.

The pieces of skin must have been provided after arriving at the answer to a question in relation to the possible changes in albumen composition.

Right now it is difficult to make a judgement on the complete results of this experiment. Even during motion of the satellite ship on orbit it was known that the dogs were successfully undertaking all the specific features of space flight. Therefore, Strelka's and Belka's pulse frequency before launching 90 and 75, coresponding, and respiration 60 and 24 (both per minute). This corresponds to normal. On the active portion the pulse of both grew to 150--160 per minute, one of the dogs' respiration frequency reached 240. This was an adaptation of the organism, and not a pathological change.

One of the dogs, after making 18 "trips around the world" in the course of a twenty-four hour period on the second satellite ship, gave birth to six completely healthy puppies. This is a hopeful result in the sense that the cosmic radiation which acted on Strelka during the flight, did not influence her posterity. Probably, all of these puppies, or atleast some of them, will "follow" in their mother's footsteps and help the scientists to collect exclusive information on the genetic results of sending highly-organized matter into space.

The ennumerated purposes and trends of the experiment indicate the very serious and complicated affair of studying the behavior of an organism in space and its reaction to external unusual influences. The results obtained to the present time are favorable, but they still require further study and new experiments. The process of a further detailed study will be continued, although a solution was "squeezed out" for man in the first flights into space. The scientists provided safety of the first stages of man's entry into space, so that this step would not be a

"step into nothing", a step with closed eyes.

It is perfectly natural, that the possible influence of high-energy particles on living organisms presents a known danger for future space flights. The penetrating ability of the particles can strongly influence the characteristics of semiconductors and impair the work of semiconductor instruments. In collisions of particles with the material of the shell, a retarding X-ray radiation arises, which also has a great penetrating ability.

It does not follow to think that the situation is hopeless. The experience of the operation of apperatus of space ships during their passage through the radiation belts of the earth and an estimation of the energy of the particles and their concentration provides a basis to assume that this difficulties are not insurmountable. Sufficiently powerful shielding and rapid passage through the radiation belts of the earth can guarantee safety, although both require additional power expenditures.

During the quiescent state of the Sun, an entry into space through the polar areas of the earth is possible. During increased solar activity, the radiation in these areas will be extremely intensive.

The launching and successful return of the second satellite ship to the earth, and the favorable results of the biological experiments carried out on it still did not imply that the question concerning manned flight into outer space can be considered to be finally solved. New experiments were needed, which would permit the obtainment of the extremely needed results.

Therefore, heavy satellite ships took off into the sky one after another. The fourth and fifth satellite ships successfully landed at the beginning of 1961 with animals on board.

Man flys around the planet. Dreams do not exist in such a responsible affair as the preparation of manned flight into space. Soviet scientists could not risk a human life for the sake of an external effect, sensation.

Therefore, a flight of man into outer space was not accomplished earlier, in spite of the fact that the power of the Soviet rockets for a long time was already completely sufficient for it. The necessity of solving the problem of returning, of "handing the astronaut a return ticket" excluded the possibility of carrying out a manned space flight until August 1960, when the second satellite ship would return to the earth.

It is true that in the Soviet Union the problem of returning high-altitude rockets with the aid of which atmospheric sounding and biological experiments were conducted, was solved some time ago. It is also known that models of the final stages of new powerful rockets, which were tested in January 1960, were adapted for passage through the dense atmosphere.

This leads to the conclusion that a safe flight of man in a rocket vertically above or on the line of a ballistic trajectory could have been made by the Soviet Union some time ago. This was not done only because such a flight is not, in essense, a space flight; it would provide little for the development of manned space flights and would have a faster sensation effect, than a scientific and technical effect would actually have.

A manned flight was not made even after the second space ship was successfully returned to the earth. It was necessary to guarantee flight safety in other respects.

The physical experiments, which were done by means of rockets and satellites in the last few years, have a substantial significance. To enter outer space, knowing nothing about the physical phenomena taking place in it, meant to undertake an unjustified risk.

Above all, this was related to the meteor danger. It followed to evaluate it from a quantitative point of view, in order to construct space ships accounting for actual data.

Numerous experiments permitted us to establish that this danger is not great.

Collision with a large meteor, an accident, but not an inevitability, all the more that the time of a manned space flight can always be selected with such a calculation, so that the earth will not pass through any meteor shower. In addition, it turned out that a sufficiently strong space ship hull can be manufactured, able to protect man from small meteors.

Another danger, featured by interplanetary space is cosmic radiation and solar radiation.

A detailed study of the radiation belts near the earth led to the conclusion that below them the radiation danger is not great and a manned flight above the dense layers of the atmosphere is possible. The study of the radiation belts provides a known basis to assume that the earth's magnetic field is a unique shield, which protects from the high-energy corpuscular solar radiation, those areas of the atmosphere, where the first flight of man could be made.

Before a flight into space, scientific investigations were successfully conducted and measures taken for radiation protection of satellite ships.

An important section of this work are the technical measures which guarantee flight safety. A high reliability in the operation of the rockets is needed, which can be used to launch a space ship into orbit. Accuracy is necessary to put the ship into a given orbit and it is necessary to create a reliable construction of the ship, which would guarantee heat-insulation and protection from radiation. It follows to solve the problem of returning the ship to the earth even in the case of a deceleration failure or a failure in any element of the guidance system and many other technical problems. All this had to be solved before the decision to take-off could be made. Soviet engineering brilliantly coped with all this. The reliability of the operation of the Soviet rockets and re-entry systems is shown by the numerous launchings. The launchings of the satellite ships provided the possibility for creating the space ship "Vostok".

A design of the space ship was subjected to two trial launchings before the manned flight. These launchings took place in March 1961. At that time, a dummy was placed in the pilot's seat, and dogs and other animals were placed in the cabin. The space ship had an automatic correction system from one of its axis to the Sun and an automatic re-entry system. The possibility was foreseen of the personal intervention of the astronaut in the guidance system. Other elements of the re-entry system were also duplicated. Therefore, the astronaut could land together with the ship, but it was foreseen that in the case of necessity, the astronaut can be ejected with the seat and perform the final stage of landing independent from the space ship.

All this together with other elements of the design of the space ship provided complete assurance in the success of the flight.

For providing safety it was necessary to conduct large efforts of a biological character. Upon entry of the space ship into the assigned trajectory, and upon its return to earth, man is subjected to the action of significant overloads. Ground and rocket experiments on animals provided very much in this respect. It followed to carefully study the reaction of the human organism to overloads and to provide the best endurance of the overloads by the organism. For this, long and carefully prepared ground experiments on special centrafuges were needed, where future astronauts could get accustomed to enduring the multiple enlargement in the weight of their bodies without feeling ill.

If man is faced with overloads in ground practice quite often and they can be easily produced artificially, then the affair takes on an extremely complicated and unusual aspect, the state in which man is found in space flight, the state of weightlessness. In practice, brief reproduction of weightlessness is possible on high elevators and in airplane flight along a parabolic curve. We can reproduce a state approximate to the character of weightlessness by means of emerging man into a liquid. All these investigations could provide known material on the reaction of the human organism to the state of weightlessness. This, together with the con-

clusive results on the action of weightlessness in animals in orbital flights created the probability that weightlessness is not an obstacle to the flight of man into space.

How is the viability of man in a space ship provided? For this, there exist systems of maintaining normal pressure, temperature and air composition. The astronaut is dressed in a protective suit which maintains his life and efficiency even in case of cabin depressurization in flight.

This would seem to be all...

Major Yu. A. Gagarin -- the first astronaut in the world who made a flight around the planet in the Soviet space ship "Vostok" on 12 April 1961. The beginning of manned space flights started with this flight.

It was proved that lethal danger does not threaten man from any point of view. Long physical training was conducted, the necessary clothing was created, and exhaustive tests were conducted on vibrostands, in pressurized cabins etc. But the captious doctors do not consider it possible to limit this cycle of biological investigations; they attentively study, besides, the genetic influence of cosmic radiation on biological objects on satellite ships in space flight.

And only after there was solid assurance in the complete safety of a flight around the planet below the radiation belts, did the first astronaut receive permission to take-off.

From all the astronauts who were carefully selected, excelltently trained physically and theoretically and subjected to every necessary technique, the right to make the first space flight was presented to Major Yu. A. Gagarin. This short, modest man with exceptional will and self-control was not only well prepared but could excelltently carry out the entire unusual flight.

He slept calmly the night before the take-off and was alert in the morning. Yu. A. Gagarin confidently entered the cabin of the space ship and in answer to the command to turn on the engines said: "Well, let's go!" To find oneself in the fantastically unusual conditions of space flight and to sing, see the shrouded blue haze of the earth from an altitude of several hundreds of kilometers and exclaim "how beautiful!" -- spirit and knowledge of one's job is needed for this.

Yuriy Gagarin was not a passive passenger in the flight. Under weightless conditions he retained his efficiency, maintained communications with the earth, followed the operation of the apparatus, observed a view of earth and the sky unusual for humen eyes, recorded his impressions on a tape-recorded and in the log-book and ate. All this seems to be quite ordinary work, but it cannot be approached with a terrestrial concept. It is necessary to present the complicated technology of the space ship, the unusual conditions of the space flight (the first in the history of mankind) and then it will become clear that what Yuriy Gagain did was not only a flight of a male humen being decided by responsible testing, but an advance of the creative worker, who carried out the entire program of work, which the scientists, doctors and engineers placed before him.

In the flight, Yu. A. Gagarin saw a black sky, large stars, the intolerably bright sun, the earth with her oceans, continents, mountains and rivers. It turned out that from an altitude of one hundred kilometers, the earth is visible in a blue

beautiful aureola, which is well defined, if you look at the horizon. The soft-blue color smoothly changes into azure, then to dark blue, to violet, which blends with the black background of the sky.

Everything is unusual, everything catches the imagination, and in this fantastic setting a Soviet space ship with a citizen of the Soviet Union on board swiftly completes its flight around the planet.

All systems of "Vostok-1" operated normally. Air pressure was maintained at 750--770 mm mercury column, temperature at 19--22° C. and relative humidity at 62--71%. The historical flight continued for 108 minutes, and after this time the ship flew around the earth, flew above several continents and oceans, and visited the day and night halves of the earth. The night half was shrouded by darkness, but Yu. A. Gagarin very clearly saw various details of the earth's surface, clouds and shade from them falling to the earth in the day half.

The surface of the earth, says Yu. A. Gagarin, has practically the same appearance as from an aircraft making a high-altitude flight. The difference is only in scale.

This is also understandable. If, for example, we compare the visibility from a space ship flying at an altitude of 200 km, and from an aircraft flying at an altitude of 30 km, then we can consider that it will be practically the same in any case. You see, the entire mass of the atmosphere is concentrated in its lower layers. The quantity of the air located in the layer from 20 to 200 km cannot practically influence the conditions of visibility. If we compare the visibility from an altitude of 200 or even more kilometers with the horizontal visibility near the surface of the earth at a distance, for example, of 20--30 km, then the latter is incomparably worse. The optical thickness of the air through which the rays of vision pass will be immeasurably greater.

The first space flight ended successfully. The training of the astronaut and

the flight itself was completely justified in its scrupulousness and captiousness. It proved the perfection of the design of the space ship and the re-entry system, where many technical plans were duplicated for the security of the success of this brave undertaking.

Having landed, the astronaut was joyfully greeted by both Kolkhoz members working in the field, and comrades awaiting him at the landing area. This was on 12 April 1961, and on 14 April 1961 the capitol of our nation, Moscow, had already greeted the first astronaut together with the entire country, and the whole world heard the Moscow Radio broadcasts. Yu. A. Gagarin clearly and confidently reported to Nikita Sergeyevich Khrushchev on the accomplishment of the mission of the Communist Party and the Soviet Government, and on the successful completion of the space flight.

The thankful nation, party and government highly valued the achievement of Yu. A. Gagarin, having presented him with the title of Hero of the Soviet Union, Pilot-Astronaut USSR and decorated him with the K. E. Tsiolkovskiy Gold Medal.

The reward of the head of the Soviet Government, comrade N. S. Khrushchev, the pleiads of outstanding scientists, designers, the huge number of engineers, technicians and workers for the great successes in the development of rocket industry, science and technology, for the successful accomplishment of the first flight in the world of a Soviet man into outer space inspires our scientists, specialists and workers to new creative, labor successes to the glory of the nation.

Four months had not passed since Yu. A. Gagarin's flight when the second Soviet astronaut, Major German Stepanovich Titov, accomplished a long space flight in "Vostok-2". This was a more complicated flight: for 25 hours and 18 minutes the "Vostok-2" flew in the sky of the planet, having made seventeen "trips around the world". The length of his trip consisted of 700,000 km, which is almost equal to the distance to the moon and back.

The "Vostok-2" weighed 4731 kg and adapted for a long space flight. As was

"Vostok-1", it was supplied with installations for automatic control of the flight and landing of the ship on the earth. The astronaut had the complete possibility to transfer to manual control, make a maneuver in orbit and turn the ship in the direction needed for scientific observations. The ship could land in any point of the globe.

Flight safety was secured by the fact that the ship was quite narrow, so that in case of failure of the deceleration system it could descend under the action of the resistance of the atmosphere to the motion of the ship.

Moscow. 9 August 1961. Meeting of the workers of the capitol at Red Square, commemorating the new unparalled victory of Soviet science and technology -- the successful flight of the satellite space ship, "Vostok-2", piloted by Pilot-Astronaut Major German Stepanovich Titov.

N. S. Khrushchev called the brave astronauts, Yuriy Gagarin and German Titov, the celestial brothers.

In the photograph: N. S. Khrushchev with hero-astronauts G. S. Titov and Yu. A. Gagarin on the platform of the Mausoleum.

The long space flight of G. S. Titov took place in conditions when the sun was quiescent and the intensity of radiation low. This indicates everything pre-

viously on the fact that our astronomers studied the activity of the sun quite well in order to favorably predict its state and provide flight safety.

During the flight, on the first and seventh turns, Major G. S. Titov switched on the manual control and the ship obediently turned in the desired direction. The same as in Yu. A. Gagarin's flight, a completely automated system of correction, deceleration and descent was utilized for the landing, but if necessary the ship could also land by means of manual control.

One of the main tasks of the flight was to study the viability of an organism and the maintainance of efficiency under the conditions of prolonged space flight and weightlessness. After Yu. A. Gagarin's flight no one disagreed with the fact that this state did not present a danger to life, but how prolonged weightlessness influences efficiency, state-of-being and the possibility of sleeping, no one knew anything of this yet.

The flight of Major G. S. Titov in "Vostok-2" ended successfully. All on-board systems maintained normal conditions in the cabin of the space ship. Pressure in the cabin was equal to one atmosphere, the temperature even in the descent portion, when flames of incandescent air raged behind the screen, did not exceed 22° C and was registered according to the heat perception of the astronaut. The percentage content of oxygen was maintained at a level of 25--27%, carbon dioxide at 0.25 ÷ 0.4%, and the relative humidity of the air was in the ranges from 55% to 75%. The air conditioning system operated irreproachably, and G. S. Titov practically did not close the helmet of his suit during orbital flight.

The prelimenary data informs us also that basically all the physiological functions of the human organism did not have pathological deviations in the flight. The astronaut's pulse in flight fluctuated in the ranges of 80--100 per minute, which does not leave the ranges of the original level before the flight. Respiration frequency was 18--22 per minute. In the period of sleep the frequency of the

pulse was lowered to 54--56 per minute, which corresponded to the background data, obtained in the long ground experiments not long before the flight.

In spite of the great complexity of the flight and the flight mission, the long stay in the state of weightlessness, the program of the flight was completely accomplished. This indicates that weightlessness neither influences the efficiency nor the state-of-being of the astronaut. It is true that certain changes took place as far as the vestibular apparatus is concerned; this was shown in unpleasant disturbances, similar to seasickness, but these disturbances were not strong and disappeared as soon as the astronaut assumed the originally selected posture and did not make any sharp head movements. These disturbances decreased considerably after sleeping and completely disappeared when the decelerator was turn on and the state of weightlessness ceased. Specialists consider that this, possibly, is due to the individual peculiarities of the astronaut.

Communications from "Vostok-2" with the earth was accomplished continuously, with the exception of an interval of time when the astronaut was cut off by the sun. Communication at remote distances was accomplished by means of shortwave transmitters on frequencies of 15.765 cps and 20.006 cps. During flight over the territory of the Soviet Union communication was accomplished on ultrashort waves (143.625 cps). This type of communications was especially reliable, since passage of ultrashort waves does not depend on the composition of the ionosphere. Earth communications with the ship was also accomplished on two waves of the shortwave band and on one wave of the ultrashortwave band.

In addition, on board the ship, there were two television devices. One, a narrow-band device, which had been used earlier in space ships. It transmitted an image with 100 line definition. The second system, a new, wide-band type, which provides 400 line definition. It passed the test in the flight of the "Vostok-2".

At the ground stations, the images were observed on screens of special tele-

vision sets and were recorded on motion picture film synchronously with registrations of the physiological functions of the astronaut's organism. Both systems operated completely normally and permitted observation and fixation of the astronauts behavior under weightless conditions.

The design of the space ship predicted two possibilities for landing the astronauts together with the ship and ejection with a parachute landing. G. S. Titov was offered the possibility of using any of these methods. Upon terminating his flight, he decided to eject in order to test that system: it was already clear that landing together with the ship is completely successful. On 7 August 1961, the space ship and the astronaut himself, German Titov, safely dropped in an assigned region near the place where Yuriy Gagarin landed on 12 April 1961.

G. S. Titov was enthusiastically greeted by the local inhabitants, and after two days Moscow greeted the new hero of space. Major G. S. Titov clearly reported to Nikita Sergeyevich Khrushchev on the successfull accomplishment of the mission of the Central Committee of the Party and the Soviet Government, and on the faultless work of the equipment of the space ship.

The high title of Hero of the Soviet Union and Pilot-Astronaut USSR was awarded to G. S. Titov. The Presidium of the Academy of Sciences USSR presented him with the K. E. Tsiolkovskiy Medal.

Thus, a second, still longer space flight was accomplished. G. Titov, as did Yu. Gagarin, saw the earth with her oceans and continents, with rivers and mountains, pastures and fields, the lights of big cities, white polar caps, and the clouds floating above her surface. He saw the velvet black sky with non-twinkling stars and the surprisingly pretty rainbow transfer from light to dark and the azure aureole on the horizon. Day changed into night seventeen times for him in one 24-hour period.

Much was done by the first Soviet astronauts. As the President of the Academy

of Sciences, USSR, Academician M. V. Keldysh, remarks -- the flights of the Soviet satellite ships indicates, that not long from now, when man will penetrate far into outer space, there will be dreams of flights to the moon, Mars, Venus and even farther into the depths of the Universe. Mankind entered a new era of mastering the hidden secrets of nature, found in the depths of space.

Man penetrates into space... The first Pilot-Astronauts of the USSR, Yu. A. Gagarin and G. S. Titov, said, that they and other astronauts want to "fly for real, to fly to the Moon, Mars and Venus..."

The outstanding successes of the Soviet scientists and first Soviet astronauts in the investigation of space far exceed what has been attained at the present time in the USA and other capitalist countries. As a matter of fact, on 5 May 1961, there was accomplished a flight along a ballistic trajectory -- a version of a manned flight in a rocket, rejected by Soviet scientists as having no prospects in a scientific and technical aspect. Lieutenant Commander of the U. S. Navy, Alan Shepard, was launched from Cape Canaveral, located in a special capsule of the "Redstone" rocket. Having reached an altitude of 180 km, he landed in the Atlantic Ocean after 15 minutes at a distance of approximately 500 km from the launching pad and was taken on board an American aircraft carrier. The maximum flight speed consisted of 8800 km/hr. The same flight in July 1961 was made by another American astronaut, Virgil Grissom.

These flights were undertaken in the USA in pursuit of sensation. But sensation was not obtained. In order to be convinced of this, it is sufficient to remember the figures characterizing the flights of the Soviet astronauts, Yu. A. Gagarin and G. S. Titov.

According to the scientific data obtained, the flights of the Soviet astronauts stand on an incomparably higher level. A whole complex of biological problems was solved. This permitted us to make a conclusion of tremendous scientific

significance concerning the practical possibility of long manned space flights.

It is difficult to re-evaluate the entire significance of the achievement made by Soviet science and technology, laborious heroism of the whole Soviet nation and the builders of Communist society. From now on man will visit the sky of the planet. Not long ago it was still accessible only for rockets and satellites, equipped with automatic apparatus, and several decades ago it was almost an undivided domain of mystical fantasies concerning supernatural beings.

Entry into space is a study of the upper atmosphere of the earth, other planets, the sun and stars with astronomical methods. A flight into space is the utilization of new roads for super-highspeed reports between specific sources of the globe. Space flights around the earth are the first step on man's path to other celestial bodies.

CHAPTER 3

What is Possible Tomorrow

Sputnik, lunnik, automatic stations, sent towards the Moon and Venus, manned flight into space -- all these achievements of science are the property of mankind. However, probably, precisely because the satellites and rockets played the role of scientifc workers from the very beginning, the results obtained by them assume a routine aspect. We still cannot represent the earth without radiation belts, and the moon without the "Sea of Moscow". We cannot look at the sky and not remember that a Soviet man was the first to fly around the globe.

If the results which were obtained by the rockets and artificial satellites had been reached ten years ago, they could be called colossal both in quantity and significance. And this is not an exaggeration. Together with that, disregarding what had to be done, it is impossible not to admit that this is only the beginning of a grandiose future.

The outlooks in the development of investigations by means of rockets and satellites are unlimited. Of course, it is impossible to accurately determine

along what concrete path the development of any area of the investigation will go. As always in science, each successive stage is determined to a considerable extent by the results obtained on the previous stages or the manner in which the investigations in adjacent areas are accomplished.

Precisely for that reason, a discussion concerning the possible trends of the scientific utilization of artificial satellites and rockets will only deal with near perspectives, where it is significantly easier to predict the course of events. Precisely for that reason, it will not lay claim to detail. We spoke of only the specific ways of utilizing satellites and rockets. They are finding greater application in science, technology and the national economy.

It is certain that the study of the upper atmosphere, outer space, solar detail, various processes (natural) taking place near the "bottom of the air ocean", the motion of ocean waters and, possibly, the structure of the earth's crust will be the basic purpose of launching rockets and satellites in the near future. All this is necessary in the first place for a detailed and full understanding of the mechanism of the elemental processes taking place in the mobile coverings of the planet, and searches for ways of subordinating them to the creative will of man. The universal study of the environs of the earth, outer space and the sun is necessary also for guaranteeing the further stages of the penetration of human intellect into the depths of the universe and a manned space flight to other celestial bodies.

A planet in the investigator's laboratory. The launching of the first satellite, whose orbit encompassed our planet, indicated that it came to the investigator's laboratory. With the aid of the first satellites man had already attempted to examine the earth and study the space surrounding it from a great distance. It was established, as the properties of the atmosphere change with altitude, it is dynamic.

The study of the mode of the movements of the atmosphere is one of the basic tasks facing the rocket methods of investigation. Examining the features and relative advantages of rockets and satellites, one can see that satellites do not offer

the possibility of direct study of the atmosphere in a layer up to an altitude of 160--170 km from the surface of the earth, and rockets do not offer the possibility of investigating parameters of the atmosphere in large regions...

It might follow to perform rocket sounding with an allowance, so that the areas in which essential processes can be developed will not be left "untouched", and with a frequency, so that not one of them could be developed in the interval between launchings.

However, this could led to the necessity of launching a colossal amount of rockets. The solution of the problem will probably be different. By means of studying the thermal characteristics of the atmosphere, both the underlying surfaces and their change in time, we succeed in obtaining the initial values for computing atmospheric movements, in the same way as the movements in the lower layer of the atmosphere are now calculated on the basis of the data of infrequent ground stations. There are instruments which permit, with sufficient accuracy, the measurement of the temperature of bodies according to their heat radiation. They are widely utilized in the most diverse fields of engineering. Consequently, if we place such an instrument on a satellite and "run around", or, as they say, "scan" a band of the surface with it under a trajectory of motion, then we can obtain temperatures of the surface of the earth in this band, and possibly, along the entire surface of the earth, if the satellite moves along a polar orbit.

But what are the temperatures of the intermediate layers of the atmosphere? It is, of course, much more complicated to study them than to study the temperature of the surface of the earth. Here, the circumstance that the infrared portion of a spectrum has sharp selectivity can be of help to us. Certain gases, among them water vapors, ozone and carbon dioxide, in the narrow band of the spectrum absorb almost all the radiation. This denotes, that if the temperature in such a band is changed by radiation methods, then it, obviously, will be the temperature of

the upper boundary of distribution of the absorbing gas in the atmosphere. For water vapors it is several kilometers from the surface of the earth and for ozone it is several tens of kilometers. With further study of the composition of the atmosphere at various altitudes, the developement of optical means of investigating these possibilities will be broadened.

However, it will be impossible to known which altitude the measured temperature pertains to. It is impossible in this way to determine the upper boundary of gas for which the temperature measurement was made. It could be done by photographing any stable source of light near the horizon from the satellites through the atmosphere; for example, the sun. If such photography is accomplished in the absorbtion band of any gas, then the weakening of the light along the visible disk of the sun -- from its "lower" edge to its "upper" edge -- will distribute the gas according to altitude and photograph the distribution "in profile". A corresponding selection of orbital incline can be secured due to the fact that the sun in relation to the satellite will be located on the horizon for a long time. This permits the obtainment of the distribution under study in a large range of latitudes, which is very important for various geophysical problems. It is possible in this manner to also succeed in obtaining a distribution of dust in the atmosphere at all altitudes. It can serve as an indicator of atmospheric processes, not yet indicating the independent significance of studying cosmic dust.

It is not excluded that with the development of optical methods of investigation from the satellite the absolute content of any compositional part of the atmosphere will also be measured by means of immediate optical sounding.

The study of the ion or neutral composition of the upper atmosphere, and the measurement of the densities of the upper atmosphere will, undoubtedly, be continued with on a larger scale than previously. This aids in a better understanding of the course of the variations in the composition of the ionosphere which is necessary

for radio communications. Investigation of the photo-chemical reactions taking place in the atmosphere helps in the study of the complete energy balance of the atmosphere.

Investigation of the atmosphere and its dynamicity is unthinkable without a study of the energy sources being conducted in the motion of its entire gigantic mechanism. The admission of energy from the sun, its partial transformation into the radiation belts of the earth and the transmission mechanism through the atmosphere to the earth and back all present a broader field of activity for the satellites of tomorrow.

Interplanetary dust can play a significant role in the energetics of the upper layers of the atmosphere. Up until recently, it was thought that only the concentration of the dust and its relative speed was significant. It is now assumed that the dust particles in outer space must have an electrical charge, in particular those close to the earth. This charged must be formed due to photoelectric emission and capture of electrons during collisions.

The essense of the first process results in the electrons' release of the substance (dust) under the action of photons of ultraviolet and X-ray emission of the sun. Upon this, the dust particles acquire a positive charge. The essense of the second process consists in the fact that electrons, at contrasting temperatures moving faster than the positive ions, often collide with separate dust particles, whereupon they acquire a negative charge. As a result of the relative intensity of that or another process a somewhat equilibrium charged is established on the dust particle. A dust particle in its motion becomes subjected to the action of the magnetic fields of the earth and clouds of plasma ejected by the sun, which maintains its magnetic fields.

This action can add known rules to the motion of the particles and lead to a determined influence on the atmosphere. Therefore it is necessary to study the dust charge by means of satellites. It may be done by means of immediate measuring

of the dust particles' charge. However, this would evidently be difficult. A second method is also possible: separation of specific moments in the distribution of the dust, which could be stipulated by proposed processes of dust particle charges and the presence of a magnetic field. This, above all, is a dependence of dust distribution on the geomagnetic latitude, daily and latitudinal variations, and the effects of solar flares and magnetic storms.

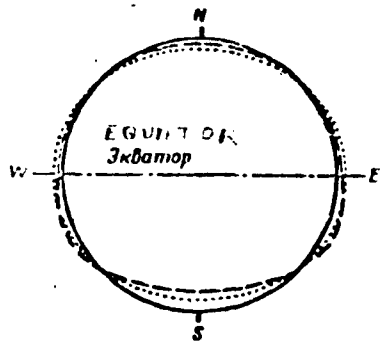
Gas particles can leave the upper-most layer of the atmosphere, the exosphere. Diffusion separation of gases takes place in the upper atmosphere, therefore in the first place the light particles volatilize. But in addition to that, the composition of the atmosphere and its total quantity remain approximately constant. The loss is compensated due to the chemical processes taking place in the earth's crust, in the atmosphere and the activity of the biosphere.

Consequently, a study of the departure of gas particles somewhere on the outer boundary of the atmosphere can place in the hands of the investigator the material for a judgement on the chemical processes in the earth's crust, in the atmosphere, on the results of the activity which maintain the "equilibrium" composition of the atmosphere. Of course, a loss of matter from the total mass of the atmosphere will be very difficult to agree upon where the densities compose millions and still smaller portions of the density of the atmosphere at the surface of the earth. But in conjunction with the study of the general motion in the atmosphere and the physical-chemical processes in it, a study of the "balance of matter" can have large significance.

If the tendency of any component part to increase in percentage content is discovered, it may indicate a serious influence on the direction of economic activity, because even insignificant contents of matter can have very important significance in live on earth and the energetics of the atmosphere.

Therefore, for example, ozone, the content of which is very little, "cuts away" the entire shortwave portion of radiation, which is destructive to living matter;

another example: carbon dioxide strongly absorbs radiation in the infrared part of the spectrum. There is an assumption that a comparatively slight enlargement of it may lead to a significant total increase in the temperature of the atmosphere, and to a change in the climate on earth. There is also an opinion that the content of carbon dioxide in the atmosphere increases as a result of the industrial activity of man and the colossal supplies of fuel combusted by him which nature accumulates.



The shape of the earth according to new data. We know that the earth is not exactly a sphere, but rather reminds us of an ellipsoid. Observations of the movement of artificial satellites around the earth permitted us to establish that the shape of the earth is nonsymmetrical in relation to the equator. Our planets has a "pear-shaped" form. The scale of deviations from the sphere and ellipsoid is enlarged for clearness in the figure. In 1961 a report appeared in the presses concerning the discovery of even more complicated deviations in the shape of the planet.

Artificial earth satellites help, with high accuracy and a large degree of reliability, to establish the shape of the planet and determine the distance between its separate points.

Precise values of the coordinates are necessary for constructing new maps, and the long measurements can provide material for adjusting the prevailing, though disputable hypothesis concerning the drift of the continents.

In specific cases it can prove to be expedient to determine the altitudes of the earth's surface above sea level by means of artificial earth satellites. As

a feasible example we can carry out the determination of the altitude of the Antarctic ice cap. A question arises in its study: what atmospheric pressure above the cap is increased, normal or decreased? This could be known if the exact altitude of the cap was known.

The most prevalent method of determining altitudes is the barometric method. It guarantee accuracy only in the case when the deviation in pressure from normal is known. A vicious circle is obtained. Determination of the altitude of the cap is difficult to do with geodesical methods due to the complexity of natural conditions. The altitude of a surface continuously changes: glaciers slowly flow, and the snow cover grows. This means an accurate determination of the altitudes of the surface of the cap could immediately help in the solution of two problems, a geodesical and a meteorological one.

The geodesical utilization of satellites for determining distance and altitudes is very perspective.

Artificial satellites also help in the study of the distribution of masses in the earth's crust. For this, a highly accurate orbital registration is necessary. It, of course, will be attained in time. A comparison of the terretrial abnormalities of gravitation and abnormalities far from satellite orbits offer the possibility of determining the depth of the occurence of the "surplus" masses.

It is necessary to know how masses are distributed in the earth's crust in order to study the general structure of the earth and further utilization of natural riches.

Geology, especially contemporary geology, does not seek natural riches blindly. A chart of the geological forecast is always constructed on the basis of various signs, among them physical. Precisely with the aid of a geological forecast we discovered, for example, deposits of petroleum between the Volga and Urals and diamonds in Yakutiya. Of course, satellites cannot discover petroleum and diamonds, but data concerning the distribution of masses in the earth's crust, obtained with

their aid, is important in composing a chart forecasting many resources.

A study of magnetic anomalies with the use of satellites so successfully started by the third Soviet satellite in Eastern Siberia has such significance in the investigation of the structure of the earth and in general for geology.

Study of the magnetic field of the earth with the aid of rockets and artificial satellites also permits a conclusive solution of the question concerning the nature of the earth's magnetism.

Service of the Earth. Man cannot wait until the complete study of the atmosphere ends. He is rapidly using already all of the obtained materials and technical possibilities. Satellites which permit us to keep the entire planet in their field of vision are capable of carry on operative service. Now, when there is no such service, it is very difficult to separate the investigative and operative role of satellites. The only criteria for this is to attempt to utilize satellites in traditional services. It is perfectly natural to examine this separation as stipulated.

Let us take the service of weather. Now for observing the meteorological processes there exists a cumbersome network composed of many thousands of stations which can serve a large army of people using a colossal amount of instruments, which, as a rule, are not perfected. And since the distances between stations is great, and the ocean surface is practically not covered by them, the dates between separate observations are also significant. The "nuclei of the meteorological network" are so great that substatntial meteorological phenomena can "slip unnoticed" into them. This all leads to errors in averaging according to times and surfaces of the earth, which are put together with accidental errors in specific instruments and observers.

Even more rare is a network of stations for atmospheric radiosounding which studies the atmospheric processes in the troposphere and lower stratosphere.

Precisely therefore, the idea of transmitting operative service of the weather with artificial satellites is tempting. Scientists, with the aid of satellites,

are able to more completely and acurately study the temperature of the underlying surfaces and their their variation in the course of time. This is very important for computing atmospheric motions, pre-computations of pressure, temperatures of the atmosphere in any region -- weather forecasting. Artificial satellites cannot determine now wind in the atmosphere, ground pressures and the temperature of the atmosphere. This, as before, will be in the requirements of the ground meteorological and aerological stations.

Satellites offer the possibility of setting up experiments unthinkable in earth conditions. Above all, we can trace in the planetary scale how cloud masses are formed, developed and move in the atmosphere.

Scientists performed the first experiments with the aid of rocket investigations before the IGY and during it, and also on the American satellites "Vanguard-II", "Tiros-I" and "Tiros-II". Some of these experiments did not provide a practical result and others were used only to investigate the large-scale cloud structure of specific cyclonic formations.

What offers science a study of the structure of cloud masses? The basis for determining the character of the atmospheric process which caused their existance, and possibly, the direction of its development. The movement of the cloud mass indicates the trajectory of the motion of the air mass to which it belongs. Their study can provide a representation of wind conditions at various altitudes.

Knowledge of the total content of water vapors in the atmosphere and its variations will provide the necessary material for explaining the heat and water balance of the atmosphere, the heat- and humidity-exchange between the sea and dry land.

What is the importance of studying water vapors? They are the most variable component of the atmosphere and strongly influence its temperature. In evaporation heat accumulation occurs. Its yield to the atmosphere is accompanied by condensation and precipitation. The influence of water vapors on the heat-content of the atmosphere is shown in another way: in the change in the negative characteristics

of the earth's surface by the cloud, snow and ice covers.

Photographs of cloud systems obtained with the aid of the American satellite "Tiros" and transmitted to the earth by television. Observation of the cloud systems with the aid of satellites permits the study of the detailed structure of such atmospheric formations as cyclones. The changes in the cloud structure in time provide information on the motion of air masses, the development of atmospheric processes. All this can have a substantial meaning in explaining the physics of the phenomena under study and in weather forecasting with meteorological services.

The strong absorbtion of heat radiation by water vapors creates a "hothouse effect", and prevents rapid "cooling" and the loss of heat energy by the earth's surface.

Optical methods of investigating from satellites permit us to easily distinguish a cloud cover from a snow cover. Satellites can trace not only the changes in the temperature of underlying surfaces, but both the changes in the snow cover of the dry land and the ice cover of the oceans. Snow and ice are not only the result of the detail of the atmospheric "heat machine": they influence its ultimate work, changing the physical characteristics of the earth's surface.

Satellites are convenient instruments for studying the temperatures of underlying surfaces. The measurement of surface temperatures of the sea, and knowledge

of their variations aids in the study of the mode of the surface heat and cold flows in the universal ocean. This means that satellites will be not only in meteorological operative work but also in oceanographic work, in the service of the dynamics of the sea currents and the science concerning the heat mode of the sea.

Operative meteorological service of satellites can include continuous monitoring of solar activity and the "dust balance" of the upper atmosphere. Their possible role in the changes in the heat composition of the upper atmosphere was already noted.

Still another mechanism of the action of interplanetary dust on meteorological phenomena is possible. There exists an hypothesis that the mode of precipitations is determined to a significant extent by the total content not only of water vapors in the atmosphere but the dust which appears with nuclei of condensation for droplets of water. The proof of this is the high cloudiness and partial fogs in such countries as England, where industrial dust is the nucleus of condensation for precipitations. A comparison of the time of falling of maximum precipitations is now conducted with the time of the passage of the earth through meteor rains. This method of study permits the exposure of the role of the products of combustion of meteors in the formation of precipitations.

Operative utilization of satellites will be developed in other courses which are still difficult to name. The flow of heat from the depths of the globe is investigated very little by scientists, and it, undoubtedly, exists. At large depths there are areas of heated and molten rock. The temperatures in the depths are maintained, evidently, by radioactive decay. If this is so with the earth, an unusual reactor, then it is very important to know the mode of its cooling and heat output on the surface. Those abnormalities in the distribution of surface temperatures, which cannot be explained by solar heating and heat-exchange through the atmosphere, can be explained by internal heat currents.

For carrying out such work it is very important to know the heat-conductivity

of large areas of the earth's surface. For this it is necessary to measure the distribution of temperatures in the surface layer.

Now there do not exist methods of studying the temperatures of the surface layers of the earth from satellites. But a similar study of the lunar surface on the basis of radio emission is widely in existance. Why not assume that the "reverse problem" may be solved: not from the moon, but from an artificial satellite moving in the upper atmosphere to perform temperature sounding of the surface layer of the earth?

Service of the earth does not disappear with meteorological investigations. Already now there exists a network of ionospheric stations. Scientists conduct regular registration of the changes in the composition of the ionosphere, the magnetic field of the earth and solar activity. This network is a little narrower than the meteorological net. Transmissions of part of ionospheric service by artificial earth satellites (for complete study of the ionosphere) will have a still greater significance than the meteorological service of satellites.

The ionospheric service using artificial satellites permits not only a complete study of all ionospheric phenomena and processes, but also forecasts them. Simultaneous and continuous registration of solar activity, the magnetic field and the ionosphere permits advanced forecasting of magnetic storms which disturb radio communication. After manned flights into outer space began, it was necessary to predict the possible increase in the intensity of radiation in interplanetary space and in the polar zones of the earth's atmosphere.

The utilization of satellites for purposes of communications is not limited only to ionospheric service. The band of radio waves for radio communication is overloaded. Communications on ultrashort waves and transmission of images is possible only at slight distances and limited to the remoteness of direct visibility. The utilization of them for transmission to large distances is possible only with the aid of radio relay lines, where the separate receiving-transmitting stations,

located at a distance of direct visibility from one another, receive transmission and transmit further to the next point. Such a system is complicated, awkward and expensive. High towers must be erected so the distance between stations will not be too small.

What if such a receiving-transmitting station is maintained in the upper atmosphere? Its radius of action sharply enlarges. What if it is maintained on a circular equatorial orbit at a distance not much more than 36,000 km? Such a station will make a revolution around the earth equal to a twenty-four hour period and be located above the same point of the globe. Less than half of the surface of the earth will be in its field of vision. A system of three of such satellites, placed on an equatorial orbit under angle 120° to one another, will provide simultaneous reception of transmissions on the entire globe, excluding the small areas near the poles.

This idea was discussed long ago. There is an objection. Such a "stationary orbit" will be located in an intensive area of radiation, in the external radiation zone of the earth. Radiation of sufficiently large energy can impair the characteristics of semiconductors and complicate the possibility of operation of stations for a long period of time.

True, these doubts, obviously, are purposeless. The prolonged operation of the solar semiconductor batteries and radio apparatus on the third Soviet satellite (which entered the polar areas of the external radiation belt of the earth in the process of its movement on orbit) and on "Vanguard-I" (which entered the depths of the internal belt) provides a basis to assume that operation of semiconductor apparatus will be stable.

Satellites launched onto lower orbits can be used for communications. In this case the satellites still are not stationary. They more or less pass rapidly in the ranges of visibility of the transmitting and receiving stations. With this another station is not always located on the same arm of the trajectory. Therefore

it is necessary so that the satellite will quickly receive a large quantity of information, remember it and quickly transmit according to earth commends when the satellite passes above the receiving station. Between transmission of information to the satellite and reception from it, a quite sufficient period of time passes. Such a type of communications was developed for military purposes in the USA and tested on the "Atlas-Score", the first American military satellite.

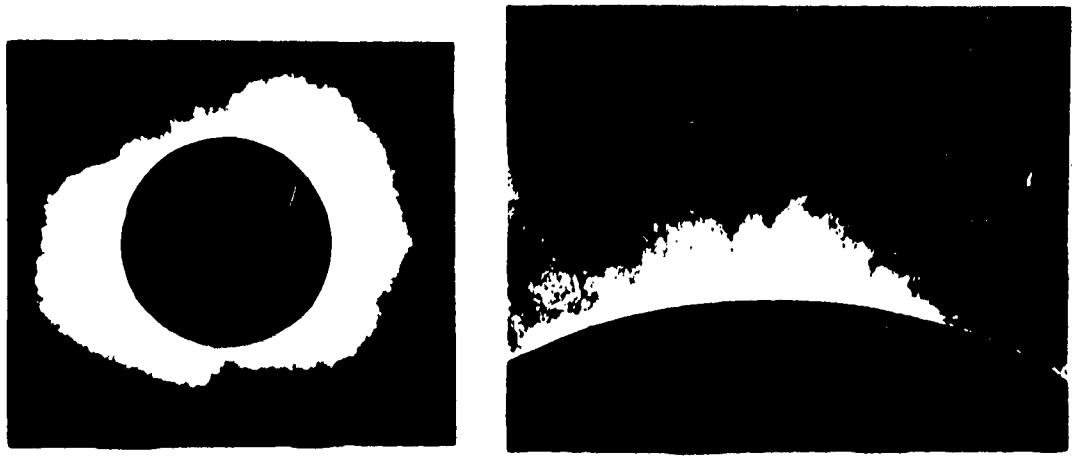
For communications purposes, not only satellites equipped with receiving-transmitting apparatus can be utilized, but those not having it also. In this case, the satellite is a passive reflector. A signal reflected from such a satellite is very weak and it loses a great deal of amplification.

Artificial satellites can also be utilized widely for purposes of navigation and determination of the exact location of a ship. We know that poor weather complicates astronomical observations. We can determine location according to the radio emission of the sun and certain stars. which passes freely through clouds. Utilization of satellites permits us to increase the accuracy of these observations.

In the depth of the solar system, in the depth of a stellar world. Broad perspectives are opened for astronomy with its exit from the limits of the atmosphere, even if one does not mention the sudden attainment of other celestial bodies. From astronomical instruments as a dense light-filter could be taken -- the atmosphere, limiting the possibilities of observation and spectral analysis only with two windows of transparency: a visible light and a band of radio emission with a wave length from 1.25 cm to 30 m. Above all, this exit from the limits of the earth's atmosphere has significance for studying the sun.

The sun is a gigantic thermo-nuclear reactor, in the depths of it self-regulating nuclear reactions are taking place at colossal temperatures and pressures. In the normal course of the process the sun emits a comparitively stationary flow of energy. A detail investigation of all types of emission is required for an understanding of these processes: from the hard X-ray emission to the radio-emission of large wave

lengths. This is stipulated by the fact that various belts of radiation can provide different information on the nature and composition of the radiating substance, and on the process of the thermo-nuclear and chemical reactions in the firey element of the sun. Separate external layers of the sun are transparent for radio emissions of various wavelengths; their study permits us to somewhat remove the external covers from the sun and look into its more deeper layers.



The solar corona. The sun is not simply a bright sphere with sparse dark spaces on the surface. Gigantic explosions in its internal areas and violent processes in its external shells lead to the the ejection of coagulates of so-called corpuscles from the sun, which are charged particles. These particles are directed into interplanetary space as clouds of plasma or "solar wind". They reach the vicinity of the earth, causing magnetic storms, and influencing the temperature and motion of the upper atmosphere. During solar eclipses the corona of the sun is easily visible. An exit from the limits of the atmosphere is extremely important for studying the sun. Neither the shortwave-, nor the corpuscular radiation of the sun, so strongly influencing the atmosphere, penetrates through its thickness.

However, the conditions of the physical processes on the sun are not always stable. From time to time gigantic masses of incandescent plasma burst through the overlying layers and as currents of charged particles are thrown into interplanetary space. Upon this, the intensity of short-wave--ultraviolet and X-ray emission sharply increases. Of course, there are corpuscular and hard shortwave

emissions at the "quiescent working conditions" of the sun. During the flashes they grow catastrophically. Interplanetary space is filled with clouds of charged particles of high energy. These clouds burst into the atmosphere of the planets, causing changes in their composition and bringing about magnetic storms. They complicate their own existance and future flights of man into interplanetary space.

Artificial satellites, moving along an extended orbit around the sun, permit the accomplishment of investigations of the corpuscular radiation of the external areas of the solar corona, an explanation of the dynamics of the propagation of the clouds of plasma, and consequently, the character of the action of this plasma on the atmosphere of the planets.

It is possible to neglect such a "solar probe" in the modern state of rocketry. It is much more difficult to transmit information from it. Powerful radiotelescopes are exclusively required for reception. A perfected radio-transmitting aparatus is also needed. It is sufficient to say that in the launching of the American rocket "Pioneer-V" communication was at a distance of 37 million km instead of the proposed 80 million. For tracking, the most perfected radiotelescopes in the world were utilized, among them the radiotelescope from the British Observatory in Jodrell-Bank, with a diameter of the antenna greater than 70 m. In comparison with the distance of the earth from the sun, approximately 150 million km, this is not much. A detailed study of the sun and other planets requires the guarantee of radio communications on a significantly greater distance than the distance from the earth to the sun.

How can this be attained?

-- Among the other large contributions of science to practice, -- says Academician L. A. Artsimovich, -- it follows to indicate the completely new trend originating in the last few years of utilizing the laws of the atom world. It can be called atomic radioengineering (sometimes it is called quantum radio-physics). The sense of this name is not difficult to explain. Already on the brink of our 100th

anniversary it became clear that each atom represents a tiny radio station, the entire mechanism of which is hidden in its external electron shell. However, over the course of a length of time, it never occured to anyone that we can use this property of atoms, compelling them to oscillate together in the same rhythm and to send an adjusted flow of emissions. Such an idea appeared a comparitively short time ago. Its authors were the young Soviet physicists A. M. Prokhorov and N. G. Basov.

At the present time it becomes obvious that new atom radio stations can lead to an original revolution in communication engineering. With their aid, obviously, we will succeed in creating communications as fine as a needle together with exceptionally powerful beams of electromagnetic waves and light rays, and by using them, we will be able to transmit signals far beyond the limits of the solar system to many millions of kilometers. It follows to assume that here the affair passes faster than with thermonuclear synthesis, and already in the next 5 to 10 years atomic radio stations will take their due place in practical life.

The study of other stars, nuculae and cosmic radiation is also convenient to carry on with the aid of artificial satellites. The atmosphere then will not prevent the study of electromagnetic emissions and the investigation of the particles of primary cosmic radiation possessing colossal energy. This helps in approaching the mystery of the secret of their origination. Ofcourse, everything that concerns stars bears the character of observations and spectral analysis at distances which are determined by nature.

The planets now turned out to be in a more "advantageous position", in particular the closest ones, Mars and Venus, and, of course, our permanent satellite, the moon. Contemporary rockets can reach the closest planets. Simple calculations indicate that the power of the engines of the contemporary rockets now is already sufficient to bring an instrument container of significant weight to the vicinity of the closer planets. The first Soviet space rocket (which passes three fourths

the distance between the orbits of the earth and Mars in its motion along an elliptical orbit around the sun) and the automatic interplanetary station launched to Venus on 12 February 1961 can serve as examples.

It is perfectly obvious that for flight to other planets much higher accuracy is required for guiding the rockets than for satellites which reach or fly around the moon. Higher requirements are needed for guarenteeing tracking of the motion of an interplanetary rocket and for securing communication with it.

Which planet out of the nearest neighbors of the earth, excluding the Moon, presents the greatest interest for investigation?

This question cannot be definitely answered. Both Mars and Venus are interesting, and both will be unconditionally studied. An interplanetary rocket flight to Venus has known advantages. A somewhat lower initial speed is sufficient for the flight (approximately one percent). Less rigid requirements are set forth for accuracy: in a flight to Venus the same error in the initial speed leads to a deviation of two, again less than in a flight to Mars. The duration of the flight along a semi-elliptical trajectory is almost half as much as in a flight to Mars. Venus can be easily investigated due to the more frequent recurrence of a time favorable for flight.

It is easier to secure communication with Venus than with Mars, because of the smaller distance between the orbits of Venus and the earth, than between the orbits of the earth and Mars. But this advantage may be reduced to zero with a greater probability of interferences, which can be created by the corpuscular currents of the sun. Precisely therefore, the trajectory of the Soviet AIS, sent to Venus, was calculated in such a manner, so its approach to the planet would not take place at the shortest distance between the earth and Venus (approximately 40 million km), but at a distance of 70 million km.

Spectral investigations of the atmosphere will play a very important role in the study of the other planets with the aid of satellites. Since instruments will

transported beyond the limits of the atmosphere of the earth, it does not follow to surmise that from the registered data it is related to the atmosphere of the earth and that the planet under study is not related to the atmosphere. The approach of instruments to the atmospheres of these planets enlarges the resolving ability of the apparatus. Entry into the atmosphere under investigation offers the possibility of the immediate determination of its composition by means of utilizing mass-spectrometers or taking samples.

Optical and radio engineering methods permit us also to learn the character of the surface of the planets and their physical properties. This is especially important for studying Venus, since its surface is always covered with a solid cover of clouds. In order to study Venus better, it follows to launch a rocket into the orbit of its artificial satellite and track its motion. Why is this necessary? Because of the absence of natural satellites of Venus it is very difficult even to provide an accurate determination of its mass and to obtain information on the magnetic field of Venus, on the formation of its existence from high-energy particles, similar to the radiation belts of the earth.

In order to study Mars we must photograph its surface from a close distance, solve the mystery of its canals, seas and satellites, and explain whether or not there is vegetation on the planet.

The landing of rockets on Mars and Venus was described many times by various visionaries. It is difficult to say what it would actually be like and what information the first automatic station or rocket launched to another planet will transmit. It is possible that it will be an automatic station which will transmit to the earth information on the composition and properties of the soil, the seismic life of the planet, temperature, pressure of the atmosphere on the surface of the planet, heat balance etc. It is difficult to propose which information will be the most valuable. When very little is known, any information is important, and logical

constructions and further stages of investigation will make up the picture obtained.

After studying the nearest planets we will consider the more remote ones. They have their own peculiarities in composition and structure. Their investigation will permit the obtainment of an over-all picture of the structure of the whole solar system.

After investigation of the nearest and furthest planets, and also the study of interstellar media, meteors and asteroids, and the activity of the sun, the scientists will be able to construct a completed theory of the origin and development of the solar system. Study of the other planets will help us in learning the different stages of their development, the composition of their hard crust, its structure, movement in the atmosphere as a whole and its specific component parts. We will also be able to determine the motion of water, if it is discovered on any planet in liquid form. By means of studying the radioactivity of rocks we will be able to establish their age the same way as it is done on the earth. When the rocks of the other planets "speak", there will be much more data for constructing a truly complete and authentic cosmogonic theory of the origination and development of the entire solar system as a whole and each planet specifically.

Our closest cosmic neighbor, the moon, presents special interest. It is quite large in its dimensions, so that the story of its formation and development is unique instead of typical. The absence of a dense atmosphere on the sun provides a known basis to assume that it is an unusual tectonic and geological museum, where everything that is not found on the very surface can be kept in its primary form. Of course, surface layers cannot be characteristic if their formation occurs in the absence of an atmosphere, and the very surface is changed, ground into dust by continuous bombarding with large and small meteorites.

The study of the "atmosphere" of the moon (its rarefied gas envelope) causes significant interest. Since its particles are continuously volatilized, it must exist only due to the separation from the bowels of the moon of different gases, the

products of internal chemical processes and radioactive decay. This means that the study of the composition of this "atmosphere" will provide the basis for making a judgement on the life of the deep areas of the moon. A prolonged continuous observation of the gas balance of the moon can be accomplished with the aid of an artificial moon satellite. The satellite will provide information on the working conditions of these internal "cosmogonic mechanisms" of the moon. Moon satellites will have much greater possibilities for studying mineral resources than any other celestial bodies, excluding, maybe, Mercury.

This data can be supplemented with seismic investigations of the moon with automatic stations launched to its surface and reporting on the composition and structure of its surface layers.

The moon is not only the closest celestial body to the earth, but one of the most interesting in the cosmogonic sense of objects. The earth in this respect "behaved" in such a way that because of the nearness of the moon to the earth we can assume that the history of their origin was common. We should note that lately there were serious doubts in this.

In studying the gas composition of the moon one must bear in mind that even one landing of a powerful rocket on the surface of the moon will substantially change the composition of the lunar "atmosphere" (so far as the small content of gases in it is concerned). It is evident that this "contamination" will be temporary until the dispersion of the gas particles returns the composition and density of the atmosphere to their original "equalibrium" values. The velocity of dispersion of the gas particles at the present time cannot be determined precisely enough by theoretical methods due to the difficulties in calculating the influence of the corpuscular currents of the sun on it. It is possible that for studying this consumption feature of the gas balance of the moon's "atmosphere" in time a special experiment will be required on the study of dispersion of an artificially created "atmosphere" or a gas impurity not characteristic for the lunar atmosphere.

What is the significance of studying the moon? It can be illustrated by a simple example. We know that now there is not a single opinion concerning the origination of petroleum: it is organic or mineral. The moon did not have the development of organic life, therefore the presence or absence of petroleum in its bowels helps answer this question.

The study of a belt of asteroids located beyond the orbit of Mars has much significance for explaning the historical development of the solar system and an over-all picture of its structure. This investigation gains exclusive interest if we can actually show that the belt of asteroids consists of fragments of the "fifth planet", moving along an orbit lying between the orbits of Mars and Jupiter.

Astronomical investigations of the solar system with the aid of rockets and satellites will have a very immediate practical significance. They will provide material for making a judgement on the history of the development of the planets, on their structure and value as sources of raw material and power for man's utilization.

Astronomy, which is now an experimental science, will be converted into an applied science in the near future. The community of goals and methods will lead to the approach of geophysics and astronomy to the tight interweaving of the problems solved by them and the practical conclusions that will be obtained. The difference will be included only in the objectives of the investigation, and then it will be relative, for example, right now the sun presents almost a similar interest for both astronomers and geophysicists.

The cosmic roads of man. Man has gone beyond the limits of the planet.

The routes near the earth are conquered and the expanse of interplanetary roads is opened before man.

It is hardly necessary to speak of the probable sensations of man in prolonged space flight. They are described many times in both scientific and science-fiction literature. The same can be said about the problems of the vital activity of man,

providing him with food, water and an atmosphere, which arise as soon as man turns from flight around the planet to flights to other celestial bodies.

Each step and detail of a manned flight must be thought out, for example, the assumption that an atmosphere of ordinary composition will be unsuitable in space flight.

What is the reason for this? The ability of nitrogen, the basic component of the earth's atmosphere which we are used to, to create radioactive isotopes. The undertaking is completely surmountable: experiments indicate that nitrogen can be replaced by helium; the means of overcoming any undertakings in a space flight will be found in exactly the same way. It is important so that there will not be any surprises in this difficult attempt.

It is very important to guarantee defense from meteors and corpuscular and shortwave radiations of the sun. There is a basis to assume that meteor danger will not be great. It can be reduced by the selection of trajectories which exclude the possibility of encounters with meteor rains, the motion of which is well known. In flights to other celestial bodies we ought to consider that meteors are concentrated in the plane of the ecliptic.

Protecting man from ionizing radiations is a complicated problem. For flight into the external layers of the atmosphere under the cover of "magnetic armor" of the earth, these radiations, probably, will not present a substantial danger. In manned interplanetary flights there is this danger. In particular this will concern those powerful explosions on the sun, when colossal quantities of high-energy solar corpuscles are thrown into interplanetary space and hard radiation is intensified. We cannot doubt that this problem will be solved.

Right now in the foreign press we see reports on the processing of various protective materials and constructive methods of solving this problem. For example, an assumption deserves attention concerning the installation of a small "emergency section", in which crew members could be sheltered during the solar explosions.

The small dimensions of this section in conjunction with the development of new more effective protective materials permits us to make the protection safe and without an increase in weight.

This is an old riddle: "What is faster than everything in the world?" The answer was: "A thought". Now it turned out that in a century it will not be so fast. Without automatic installations it clearly would not be able to secure the guidance of space ships when it would take only a fraction of a second to arrive at solutions and execute them.

Man will not stand at the controls of a space ship without automation. Automatic installations permit well-timed performances of all operations during take-off or landing and transfer to new orbits. Automatic installations will also perform many operations in the study of parameters of outer space and in the study of the other planets.

They were very well recommended in past stages of investigation. In an age of automation, when man undergoes the most dangerous operations in all fields of his activity with automatic installations, it is difficult to think that evolution will be reversed in the field of space investigations. Try to imagine that the contemporary computation machines will be replaced by hundreds and thousands of computers, that compact and reliably operating automatic interplanetary stations, photographing the moon, will replace man, which will photograph the moon and planets, develope the photographs, transmit them to the earth... We get a prepoeterous picture.

However, if the scope of man's duties becomes narrower, won't flight to other celestial bodies be deprived of a practical sense?

In sending man to other planets, we ought to give him a command assignment, otherwise instead of a command certificate , future astronauts will be presented with a tourist visa.

Very often the purpose of a flight to other worlds is thought to be a search

for exotic treasures or raw materials required for man's activity on the earth. But we know now and that in the near future the transporting of even very valuable materials from other celestial bodies will be unprofitable.

In an era of space flights and attainment of other planets we should not consider that the other fields of science and technology will remain at their present stage of development. It is certain that new deposits of mineral resources will be discovered on the earth, which are now deficient. Many of them will become inexpensive after the perfection of methods of extraction or will be created from non-deficient materials, replaced by more improved artificial materials. There are many such examples in our daily life.

Processing of new synthetic materials can make not only the transport of certain kinds of raw material unprofitable from other planets, but also their extraction on the earth. Man's creative possibilities give him much more for developing his economic and cultural life, than exotic treasures.

Ofcourse this does not mean that man is limited only to the things he has on the earth. Many ideas are alluring, for example, to produce a chemical and nuclear rocket fuel in a designated point on other planets. This would permit us not to bring fuel for the return trip or for continuing it. And it is certain that the raw materials and power resources of other celestial bodies will be utilized to a fuller extent, when man masters them for the establishment of constant observatories or simply for life. But it is also certain that the penetration of man into space is not tomorrow, but the day after tomorrow.

Therefore, the next goal of a manned flight into space is the study of the other celestial bodies. We should not fear that the ever expanding role of automatic installations indicates that there is not a role for man. There will be work in abundance for him. In all investigations and at all stages, where favorable experiment programming is impossible and a change in its mode of performance can be required, a wide field of activity is opened to man. It will be necessary to

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comprehend the results obtained, in order to have the possibility of checking them or continuing in the needed direction. Those phenomena which can prove to be unexpected or have a small probability of detection will not slip away from man's attention or his observation.

This can pertain to geological investigations, to the study of the composition of rocks of other celestial bodies and vulcanic activity, in particular, if it is not very extensive and is not continuous. It can be fully applied to biological investigations. It is difficult to imagine that automatic machines will perform such an important branch of investigations. An animal and plant world, if there is one on the other planets, the microorganisms of other planets -- all this can be completely studied only by man.

The study of life on other celestial bodies is very important not only for an acquaintance with their nature. It is necessary for explaning the general laws of the origin and development of life, which has a very immediate meaning for maintaining the health and life of man, and a more effective development of the earth's biosphere.

In order to study the life forms of other planets, it will be necessary to apply strict measures of precaution in the landings of rockets. Precautionary measures will also be needed in man's immediate "acquaintance" with unknown microorganisms, which can prove to be injurious. We must also not permit the "contamination" of other celestial bodies with microorganisms of terrestrial origin. Besides the destructive influence on the nature of other planets, it is undesirable also because in the successive study of nature it will be difficult to distinguish the "local inhabitants" (aborigenes) from the microorganisms of terrestrial origin and an erroneous representation of the nature of the planet under study can arise.

Precisely for this reason, the second Soviet space rocket underwent special processing before its launching to the moon and corresponding measures will be applied either in further investigations connected with landing, or simply the fall

of rockets onto the moon or onto planets. Exactly the same processing will be done to the ships returning from space trips.

Other possibilities. Very often, when the conversations turns to artificial satellites, the question is examined concerning the utilization of solar energy. Generally speaking, this energy is already being used now. Solar batteries were installed and proved themselves very well on many satellites and space rockets. Their application, undoubtedly, will be even broader. There is a basis to assume that the efficiency of solar batteries is increasing. At the present time the efficiency of the best batteries does not exceed 13%. It is possible that it will increase up to 23%. This means that almost one fourth of the solar energy falling on the element of the battery will be converted into electrical energy.

We can assume that the utilization of solar batteries will provide a solution to the problem of securing power for the apparatus of future space ships and maintaining the necessary vital conditions where ever man is found. Namely the energy of the sun will provide prolonged operation of the apparatus of all earth satellites and even more so for the moon and other planets designated for prolonged study or for operational services. Can solar batteries be applied for securing the electrical power primarily of the new engines of future rockets? Probably, this seems difficult and the advantage will be on the side of nuclear and thermonuclear power sources.

Obviously, neither solar batteries, nor any space mirrors will be able to collect a significant amount of solar energy for utilization on the earth. For this, we could create surfaces that would be to great to be subjected to any kind of danger. In addition, we must simultaneously solve the problem of transporting the energy obtained to the earth: in the form of immediate transmission or by means of the creation of super-effective accumulators.

That is why the significant magnitude of the flow of solar energy which can be effectively used on the earth is difficult. at the present time. Greater suc-

cesses will undoubtedly be attained in the utilization of solar energy on satellites, rockets and space stations of the future.

There is still one proposal not immediatly connected with satellites, concerning the utilization of solar energy. Its essence consists in the creation of a gigantic and quite complete ring around the earth, composed of crushed dust particles, similar to the rings of Saturn. It is proposed that these particles, being sent into an orbit around the earth at a sufficiently great distance from it, will move along this orbit for an infinitely long period of time and, reflecting the solar rays hitting them to side of the earth, will be able to enlarge it radiation balance.

Such a proposal is unfounded and, unconditionally, cannot be realized; it meets a number of serious objections. First of all, the efficiency of such a "mirror" cannot be high, because it will not only reflect, but also diffuse light on all sides; secondly, the effect of such a ring will be seasonal; being created at any moment perpendicular to the solar flow, it will become parallel to it (like a giant gyroscope, it will maintain the axis of its rotation in relation to space), and then for a long interval of time it will not be a mirror, but a shield.

At the same time, the creation of such a ring in a plane of the equator, upon which a seasonal effect could not take place, because in this case a shield will be created above the tropics, where a dust shroud always (if one assumes that the ring will last a century) hide the sun. Thirdly, such a ring cannot exist for a long time. Dust particles, possessing a small mass and relatively large surface, will quickly lose kinetic energy as a result of collisions with dust and gas particles of the interplanetary medium. Besides, due to photoelectric emission and collision with free electrons of the interplanetary medium, the dust particles acquire an electrical charge. Upon movement along a polar orbit they will be exposed to the action of variable pulsations of the earth's magnetic field, and intersect in its motion the power lines of the constant component of the magnetic field. All this

causes very complicated and large disturbances in the motion of the particles, and leads to the fact that the existance of such a ring will not be long. Actually, such a ring could enlarge many times in concentration of particles in a dust cloud, surrounding the earth, and could make the radiation balance of the earth worse and could complicate optical observations.

Artificial satellites can help verify the theory of relativity. Usually this question leads to the verification of one of the conclusions of the theory of relativity, the time paradox. Actually, modern technology does not permit the creation of such atomic clocks, which could move along an orbit around the earth with a corresponding speed for a long time. After the return of the atomic clocks to the earth and their readings are compared with the readings of similar clocks, which counted off the time on the surface of the earth, one can answer the question concerning the presence or the absence of the time paradox with a sufficient degree of reliability.

Of course, this is not a singular method of verifying the theory of relativity, although other methods cannot be so graphic and demonstrative. There are, for example, proposals to verify the theory of relativity by means of observation of the angular displacement of the perigee of the satellites. The magnitude of such a displacement of the perigee of Mercury, which has a large speed of motion than the other planets, consists of approximately 40" in a century. Calculations indicate that the displacement of the perigee of the satellite will be approximately 30 times greater and therefore it can be easier detected.

This is a long, but not complete list of all those principles for verifying the theory of relativity, which became possible with the creation of artificial satellites. Satellites are one of the most perspective instruments for verifying the theory of relativity.

Unconditionally, the possibilities of the scientific utilization of rockets and artificial satellites are not drained with the shown examples. These applica-

tions can frequently be very unexpected. One cannot doubt that artificial satellites and space rockets open exclusive possibilities for science. They will be continually expanded since the satellite, space ship, and space station will become ordinary instruments or means of scientific investigations.

CHAPTER 4

The Cosmic Future of Humanity

The scientific possibilities of man in our time are growing extraordinarily fast. The fantastic or simply unbelievable yesterday becomes the real today.

A little more than one hundred years ago, a French agnostic philosopher, Agust Conte, maintained that man would never know the chemical composition of the stars. One hundred years passed, and not only the chemical composition of the stars, but also the chemical composition of remote nebulae was studied due to spectral analysis quite well, even better, than the composition of the planets closest to the earth.

The margin between reality and fantasy wears away at the present time with an ever increasing speed. Soviet man has learned to create new substances, which nature did not know of, he has penetrated the secrets of the atom and the depthes of the ocean, launched rockets to the moon and around the sun and himself performed the first flights around the earth on satellite ships. Now it is even more difficult to name a problem, which could have been completely determined, that it would be impossible to solve.

The enlargement of our possibilities is determined by the development of economics and science. Descriptively speaking, science is a projector, with which Soviet man illuminates his future. Each discovery, and new technical stage renders the most immediate influence on the most ulterior trend in the development of science and economics. All consequences and perspectives of that or any discovery is not always foreseen immediately. Galileo, directing his telescope to the moon, did not think, of course, that this was the beginning of the visual study not only of the

moon and planets, but both the composition of other stars and remote galaxies. A long improved telescope and the invention of spectral analysis was required to make this possible. Many similar examples can be given.

The launching of artificial satellites and space rockets, and the entry into outer space, undoubtedly, has an exclusively large influence not only on the development of science, but also of mankind.

K. E. Tsiolkovskiy was the first to understand this. His merit consists not only in the fact that he pointed out the means of entering space. Tsiolkovskiy was the first to meditate over the fact of which effect this has on the ulterior development of mankind. It is possible that his specific proposals do not turn out to be completely correct, since at his disposal was very little data on the physics of interplanetary space and what effect the conditions of space flight will have on living organisms. The prime importance rests in the fact that he placed the question concerning the future of humanity, concerning the purposes and the idea of space investigations.

But is there meaning, say some people, to ponder over this remote future, maybe, to submit to the natural logic of events and the development of internal regularities?

Of course, one must think of this in order to see a clear perspective of an ultimate way, to include the element of conscious regulation in the trend of the development of events, so that the development of events would be the most effective. The smaller the elements not considered in the work, the smaller the labor and time consumed in vain.

It is unconditionally impossible to foresee everything up to the smallest detail. To the reader of the 21st Century, our presentations concerning the future seem very naive and unconvincing, since proposals of people of the 19th Century are now being presented to us. And it is no less possible to attempt to present the basic directions of man's activity, on which an entry into space has the lar-

gest influence. One can also determine to what extent this step influences the development of mankind, its attitude and on existance in general.

Master of the planet. In an astronomical sense, the earth is an ordinary planet of the solar system. Just as the other planets it can be studied with the aid of modern means of space investigations. But the earth is extremely more attainable for science, than any other planet. The study of the earth has a primary significance in our days, when man can actively fit in the natural processes. The development of rocketry leads to the fact that not only the environs of our planet, but also all the very remote corners of the solar system seem to be within man's reach, in the sphere of his activity.

Knowledge of the solar system and the regularities of the development of matter in the stars and galaxies leads to a perfectly clear and detailed representation on the structure and composition of the earth. This permits an extremely fuller utilization of the raw material resources of the depths of the planet, which for already millions of years have been lying at various depths as a useless treasure. That which is now being used by man is no more than a slight dissemenation of those or any substances and minerals, which were formed in the surface layer of the crust or which have fallen into the surface layers from the depths in the process of the formation of the terrestrial crust.

One can think that even for many millions of years the earth will remain the home of man. What resources does man have on the earth? The development of technology will make the depths of the ocean attainable. The giant "azure virgin land", occupying an area 70% of the surface of the globe, increases the productive possibilities of the national economy. Even if one assumes that the entire surface of dry land, including Antarctica, the spaces and rocky slopes of the mountains, is to be used for production of food products, then the area of the oceans with temperature conditions more favorable for the development of life than the conditions on dry land, will be almost two and a half times greater. This ratio could

increase many times. The living substances in the ocean use not only the bottom or the surface, but also the entire width of the waters.

Yet only one of these perspectives of a greater utilization of the oceans makes an incompetent "theory" concerning the overpopulation of the planet and concerning the limit of the possibilities of its use for the obtainment of food products.

But not only in this respect. Reaching the depths of the ocean makes possible the use of the mineral riches, which are found under the mass of water. Geologists are prospecting the bottom of the sea and are working out projects of deep drilling of the earth's crust under the ocean. They will penetrate all regions and depths of the ocean and remove the blank spaces from the geological chart of its bottom.

We now already know such examples of the utilization of the mineral riches of the sea and the resources of the bottom of the sea: the extraction of salt in the Kara-Bogaz-Gol Bay and petroleum from under the bottom of the sea near Baku.

But these examples are a promising beginning. In time, probably, not only on the water, but also under the water automation enterprises will emerge for extracting raw material and fuel.

In our time, after the launching of satellite ships, no one, perhaps, doubts the possibilities of a prolonged flight into outer space and the attainment of other planets. Ultimately, "ethereal islands" and settlements can be created on other planets. It is probable that their creations and the equipment of underwater enterprises and even settlements will be the links in the single chain of development of human society, tightly linked between each other. In this, it can be very possible that the study and economic mastery of the depths of the ocean will be met with small difficulties, smaller than the mastery of remote planets. The study of the depths with the aid of satellites will provide the initial material for composing charts of a geological prognosis of the terrestrial crust, and the bottom of the sea in addition. New rockets for overcoming outer space can be constructed from

metal, extracted from the bottom of the sea, and the heavy hydrogen extracted from sea water can become their fuel. Thus, the very diverse perspectives of human activity can be closely interwoven.

Man will penetrate even deeper into the depths of the earth's crust. He will compose a guide map of the earth's crust with the aid of such a perfected means of planetary investigations, as artificial earth satellites. The attainment of great depths, possibly, requires the creation of those or any industrial enterprises in an immediate distance from the sources of raw material and makes the activity of man incomparably more "versatile".

This sounds somewhat fantastic now. At the same time the construction of "sublunar stations" is represented by necessity only because of the existance on the surface connected there with great dangers.

A basic obstacle on the way to the earth's depths is the great labor capacity of the necessary work. But with the development of mechanization and power resources construction of underground equipment and underground roads will be possible, precisely since both the creation of illumination, in particular the corresponding intensity and spectrum of solar light. It is very possible that the large and mechanized plants and metropolises of large cities are the first stages in this path. The difficulties, of course, are great, but they are significantly smaller than those which which will be encountered on other celestial bodies upon the installation of such underground enterprises and settlements. What is the advantage of penetrating into the depth of the earth and other celestial bodies? Above all, in the possibility of utilizing the heat of the internal layers. Temperatures at comparatively small depths are such that not a heating there is required in all latitudinal belts and in any season. At very large depths it is necessary, conversely, to lead off heat, which can be used for heating residences and enterprises on the surface and will provide "free" and practically permanent heat sources. The giant heat machine of the earth will operate in such a manner as to secure favorable con-

ditions for life in the most diverse regions, in order to provide the maximum power for living and industrial needs.

It is already known now that at a depth of several hundreds of meters or several kilometers there are seas of hot water, the very same as those which appear on the surface in the form of geisers, or hot springs. This "free energy" can be utilized in industrial and living needs. Investigations and preparatory work is going on for the utilization of this energy stored by the depths of the earth. Scientists must verify, is the hypothesis true concerning the fact that the earth gradually cools off, and the energy of the natural nuclear reactor is reduced? Do the high temperatures of the depths of the earth maintain nuclear decay of radioactive elements?

Science helps man in the formation of nature.

The future of the planet and mankind, communism, will secure not only an enlargement of the material and economic resources, but also the radical conversion of the conditions of life on it.

The more actual, the more real becomes the question of our time, the domination of man over the forces of nature and in the first place, over weather.

The energy of atmospheric formations of a large scale is great. It is measured almost with astronomical numbers, even if as a unit of measurement we take the energy which is liberated as a result of an explosion of an atomic or a hydrogen bomb. And then no less interference in the atmospheric processes is possible. Such a task will be beyond the power of man of tomorrow.

In a number of countries work is being conducted on the dispersal of clouds, and the artificial creation of rain. Under determined conditions this effect is completely reliable, but not always for a long time. In the "mechanism" of nature the entire "design" is still not clear. The many sides of its operation require the inclusive study in order to have the possibility of forecasting what it will be tomorrow, in a month, in a year.

But this is the passive, "conciliatory" approach. It does not in the least pretend to correct those "injustices" in the distribution of heat between the polar and equatorial areas of dry land. It also does not pretend to prevent elemental disasters: hurricanes, typhoons, tornadoes and floods. That is why, in studying the essential "mechanism" of natural phenomena, it is necessary to think also of the creation of a new "mechanism" or at least of the development of definite details which, being "assembled" in the essential "mechanism", would give man the possibility of including the element of regulation in the natural processes and actively influence them.

Right now the opinion is being expressed that it will be easier to change the weather than to predict it. This comes from the fact that it is not at all obligatory, in order to have the energy of the effect be equal to the energy of the process. Atmospheric processes, even the very large-scale ones, as a rule, are unstable. A comparatively small effect can be sufficient in order to direct the development of it in another direction. Picture a rocky block on the peak of a mountain. You cannot stop its motion, when it is rolling towards you. But, being warned of its danger, you can advance and push it, so it would roll into an uninhabited region or atleast to a steep incline. In this, the influence of the falling of the block will not be so destructive. One can also bring about its falling in an interval of time when it will not be dangerous. One can reinforce the rocky block on the peak of the mountain and make its position more stable. In exactly the same way, man, in time, will learn to also control the atmospheric processes.

This control, of course, is senseless without that investigation of the role which the satellites will play in the study of the natural processes and without the operational monitoring with the aid of artificial earth satellites.

The energy necessary for a temporary effect on the elemental processes can be fantastically great. But for partial effects and for changing the climate, the energy requirements will be colossal.

Where will it be obtained? Very often, the authors of fictional books, in telling of the future of the earth, write that the time will come when man will live in outer space around the earth under artificial thermonuclear suns. Indisputably, this could be very effective and could permit to some extent a change in climate. In light of these suns one will be able to read fiction books even at night. But one should also look at these "projects" from an engineering point of view...

And then it is impossible not to arrive at the conclusion that artificial suns will not be worth creating. The idea of their creation is a simple imitation of nature, of the natural light of the system, and as a source of energy it is exceptionally uneconomical. Only an insignificantly small part of the radiant energy of the sun reaches the earth, and is used by man even less.

With the uneconomical consumption of the energy of the sun, we must put up with the fact all the more than it is intended to be practically an unlimited supply of fuel. In projects along this line, accomplished by man, such plans, will of course be impossible. Supplies of thermonuclear fuel on the earth are great, but are far from being unlimited and must therefore be utilized economically. Ignition of the artificial suns is the same as igniting a giant bonfire far from the house which we want to heat. It is much simplier and better to ignite this fuel in the furnaces of the house or even in "boilers" and transfer heat from them to the various "rooms" with the aid of a ventilation system of "central heating". Keep in mind, the requirement in these "boilers" arises only in the case if the "central heating" seems to be insufficient, that is, the heat of the deep layers of the planet or for any reason, its utilization will be difficult.

Of course, it is now impossible to imagine how man will fulfill the role of complete master of the planet and nature. It is difficult to say how abi-lity will extend into the control of nature and to foresee even all possible directions of man's interference in the nature of the planet.

As an example, let us take the possibility of man's intervention in the exis-

tance of the radiation belts of the earth.

When they were discovered, a doubt arose in some foreign scientists in the possibility of the entry of men into space. There was dissention that man was locked by these belts to the earth, as in a trap. They then began to consider the possibility of an entry into space through the polar areas, to which these objections were made: explosions on the sun in the period of flight do not seem to be any less dangerous than the radiation belts. It was later explained that the higher the energy of the particles in the internal zone became, the most dangerous it was, therefore it must be passed as quickly as possible.

The internal zone is comparatively stable, which means that its existance is stipulated by the approximate equilibrium state between the arrival and consumption of the charged particles. The "receipt of balance" is still unknown. Consumption is stipulated by collisions of the charged particles with molecules of gas in the upper layers of the atmosphere. It is completely possible that by means of ejecting the gas or dust particles in the internal zone, it seems to be economically profitable to "withdraw from circulation" all or almost all charged particles located in this area of the magnetic trap. In time, it will , of course, be fulfilled, again, but the goal will be attained, a space ship will open a road similar to that which snow-removers are now clearing the accumulated snow from.

It is fully possible that at the "cosmic gates of the planet" there will be a special "travel service", providing safety of the movement of space ships in the closer environs of the earth.

<u>In the scale of the solar system</u>. The necessary provision of safety of space flights, and the creation of powerful rockets which will permit man to leave the earth to a distance of many hundreds of millions of kilometers, will make man the master not only of his planet, but the entire solar system. Numerous automatic rockets and ships with crews will conduct investigative work in outer space and on various planets. Astronomy, which now has already become not only an experimen-

tal science, but applied also, will carry on not only investigative functions, but also operational monitoring of the processes taking place on the sun, in space, and on all the planets.

It is necessary to create various observatories and stations on other planets and their satellites. For this we must construct large rooms where man might work and live under the conditions he is used to on the earth. Probably, these will be "underground" rooms, which will be able to provide energy due to those or any natural resources of a given planet. These rooms will have an atmosphere, similar to the earth's in composition, temperature and density, and artificial lighting, originating from the usual emission of the sun on the earth.

It is possible that ultimately, separate observatories will be converted into actual cities, connected between each other by tunneled roads. Why must the first forms of man's existance on other planets be namely "underground"? Because in such pressurized rooms and tunnels it will be easier to provide the physical conditions which man is used to. In this manner, it is easier to isolate man from harmful conditions maintained by other celestial bodies, easier to provide what is necessary for life and practical activity as regards to raw material and power resources which must be, naturally, local, and not imported.

A detailed study of the structure and nature of celestial bodies, a practical experiment in the transformation of nature to the earth can in time permit the changing of the nature of other celestial bodies to usual terrestrial forms. This transformation will be derived from a large number of partial factors: an artificial change of the atmosphere for the purpose of approximating its composition to that of the earth, the creation of water circulation similar to that of earth, provision of a corresponding temperature mode and, possibly, the creation of artificial magnetic fields for protecting the atmosphere from the effect of corpuscular flows which may be ejected by the sun.

Only after such a transformation has been conducted, will man be able to go out

to the surface of another planet without a space suit, feel "at home", and not "visiting" in an unfamiliar world, where each step is threatened with dangers.

Of course, all the planets will not be able to be converted in this manner. On giant planets, where the gravity is too great, man cannot, obviously, exist without special security for a more or less long period of time. On small celestial bodies, where the gravity is not great, the creation of an artificial atmosphere of large density is a senseless affair. There, life of man can be developed only in the depths of the planet. Entry on to the surface will be possible only in a space suit. Specific dangers of space (radiation and meteorites, plus, probably, an increase in the radioactivity of the soil) can man watch for on the surface of the planet.

The forms of existance of man on other celestial bodies can depend on the presence of organic life on them.

Just how peaceful will the "coexistance" of the local forms of life and the visitors from earth be? Without an answer to these questions it is impossible to present in details the conditions of human existance on other planets.

The question of whether or not there are intelligent beings on other planets of the solar system which are higher developed than man, hardly ever arises at the present time. Obviously, there are none. It may very well be that the probability of discovering a "lost world" on the earth similar to that which Conan-Doyle wrote of, is much greater than the probability of detecting beings on other planets which are on the same level or higher than man in their development; if they did exist, then they would find a means of letting us know about them.

Communication with other worlds. The radiation of the stars of the Galaxy led astronomers to the conclusion that many of them have planetary systems. One of the ways, by which the astronomers arrived at such a conclusion was an estimation of the speeds of stellar rotation. A regularity is noted in the solar system: the planets have a mass equal to approximately one thousand total of the mass of

the system, and approximately nine hundred and eight percent of the total amount of rotation. This means, if the sun during its formation had been formed in the shape of a solitary star, deprived of planets, then it would be ten percent more massive, but would rotate fifty times faster.

As a result of estimating the speeds of rotation of other stars, it was explained that they are divided into approximately two equal groups, in which the speeds of stellar rotation in that or another group differ by fifty times. This means that approximately half of all the stars have planetary systems. Of course, not on every planet do the natural conditions permit the development of life.

How can we determine, on which planets, namely on which stars could life be engendered and developed to higher, intelligent forms? On which stars that are near the sun can we expect to find intelligent beings? In order to find the answers to these questions, a Polish astrophysicist, K. Kordilevskiy, formulated the conditions under which one can expect the existance of intelligent beings.

The first of them is included in the fact that the star must heat the planets with even light for at least two or three million years, a period which, according to earth's orbit, is necessary for the development of higher forms of life. If the flow of solar energy would essentially change after that time, then life would cease its existance, and if the earth would move along an orbit with a very great eccentricity, then it could not originate in general.

The second condition consists in the fact that the central star must be so hot as to secure the heat conditions in the planetary zone which are favorable for the development of living albumin. Stars that are too hot or too cold are excluded from consideration. It is true, this condition can to a known degree be considered relative.

The third condition requires that on the surface of the planets strong cosmic or shortwave radiation is absent. Consequently, the planets must be located far from new or ultra-new stars, and from sources of intensive cosmic radiation.

These conditions sharply lower the quantity of stars, in which, probably, we could discover planetary systems inhabited by intelligent beings. Among forty-eight stars, located from the sun at distances less than sixteen light years, thirty-seven are completely excluded from the catergory of stars, the planetary systems of which are suitable for life. Star 61-A of Cygnus, was also excluded from consideration. By means of observations for many years, an invisible planet was discovered, which was causing the star's oscillation, and the period of its revolution was computed. The reason for excluding this star from consideration lies in the fact that its luminescence is too small: only 7% of the sun's luminescence.

These are the most promising three stars: Tau in the Cetus constellation, Epsilon in Eridanus and Epsilon of Indus. It is true, the radiation of Epsilon of Indus is equal to 16% of the radiation of the sun, but this is by no means hopeless for the star to develope life.

The luminescence of Epsilon of Eridanus and Tau of Cetus reaches 40% of the sun's luminescence, and the mass is almost equal to the mass of the sun. The spectrum of radiation, and consequently, of temperature on the surface of the planets is also similar to the conditions in the solar system.

These two stars located comparatively near us are the probable points of designating where manned interstellar ships will in time go.

However, these conditions do not take into account the circumstance that the planets, the existance of which are presumed, can have a composition different from the earth, and located at other distances from the central star, rather than the planets of the solar system, and this can reduce the probability of detecting life on them.

Granted, there is an argument also in the use of expanding the conditions refered to. It is difficult to think that if the central star fades, then intelligent beings, on a high degree of development and possessing the secrets of nature, would not find a means of artificially maintaining physical conditions suitable

for life. If we continue this thought, we ought to seek the most intelligent beings precisely on these fading stars.

At the present time, man is deprived of the possibility of reaching other stars. And what is more, many consider this possibility problematic in general. Does this mean that the question of where intelligent beings can live is idle?

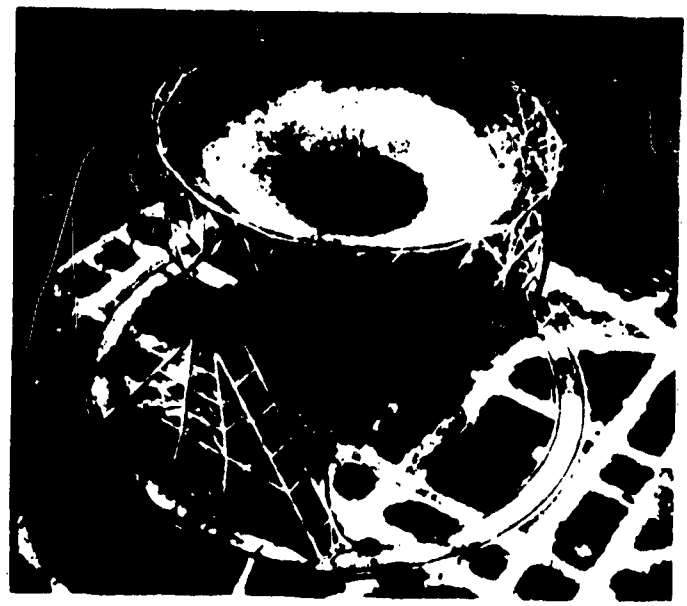
No! Recently, the possibility is considered even more realistic of establishing radio contact with intelligent beings of other worlds, with man's intellectual brothers. In September 1959, in the British journal "Nature", there appeared an article by F. Morrison and D. Coccony. In it, it was mentioned that this possibility is not only real, but is technically founded.

First of all, if one assumes, that the transmitter, the emission of which is used, has a power on the order of a thousand or ten thousand kilowatts, otherwise saying, such power, which the transmitters on our planet can now have, then the sensitivity of contemporary large radio-telescopes, equipped with molecular amplifiers, will permit us to receive radio signals, arriving from a distance up to 25 light years. And this is not the limit. With the introduction of new radio-telescopes the radius of possible reception grows to a hundred light years and more. As we see, this is significantly greater than the distance to the hypothetically inhabited planetary systems of Tau Cetus and Epsilon Eridanus.

Secondly, the band of radio frequencies, which can be used for such radio communication, must be quite clearly determined. If we exclude the frequencies which can be absorbed by the atmospheres of the planets and exposed to radio noise which may be caused by the emission of the sun and stars, the possible band will immediately cease up to the 15--150 cm wavelengths. Radio waves 21 cm long are considered to be the most probable for "interstellar" communications. This is explained by the fact that waves of such a length are emitted by atoms of neutral hydrogen. Astrophysicists are working further on this wave, studying the structure of our galaxy

and the movement of other planets. It is precisely on this wave, undoubtedly, that intelligent beings are attempting to establish communications with their galactic neighbors.

Radio signals directed from planets located near the central plane of the galaxy will be strongly veiled by natural emissions. There precisely is concentrated the largest part of interstellar gas. This excludes Epsilon Indus from the list of possible objects with which radio communications can be established.



A modern radio telescope. Up until recent times, radio telescopes were only a means of studying other celestial bodies and remote galaxies on the basis of their radio emissions. After the launching of satellites and rockets they also began to be used for observations of them. Thus, with the aid of the largest radio telescope in the world, depicted in the picture, in the Jodrell-Bank Observatory (antenna diameter 80 m) the tracking of the second Soviet space rocket was conducted and its fall on the moon was confirmed. With the help of this radio telescope the American space rocket "Pioneer-V" was tracked (up to a distance from the earth of 37 million km).

Now radio telescopes are beginning to be used for systematic registration of radio emissions arriving at the earth from certain stars, for the purpose of picking up signals in these radio emissions from intelligent beings which can inhabit their planetary systems.

The considerations brought up are the basis for recognizing not only the main possibility, but also the reality of establishing such communications. Already at

the present time, we have started registration of radio emission of 21 cm wave-lengths, arriving from Tau Cetus and from Epsilon Eridanus, and have started to attempt to separate the intelligent information from the radio emission being received. This effort was started at night on 6 April 1960 in the presence of the representatives of the Soviet Union, Sweden and Canada with the twenty-six meter parabolic antenna of the American observatory, Green-Bank.

In the consideration of the problems of establishing radio contact curiosities were dispensed with. Some foreign scientists considered it necessary, for example, only to register radio signals, but in no case to convey the same signals, so as not to cause a destructive invasion of colonists from other stellar systems whose level of development of science and technology might be higher than ours. Of course, this is not a founded danger.

Establishment of two-way communications with other worlds will mean that the people of the earth are included in the "great ring of intellect" which must exist on the basis of completely logical proposals of some visionaries, in particular I. Yefremov, between the developed civilizations of our galaxy. The exchange of experiences and knowledge in this "cooperation of worlds" will create exclusive possibilities for further development of each of these civilizations, for their complience of the forces of nature and the utilization of its riches for the good of the living.

It may very well be that the solution of the important problems now facing mankind will occur not as the result of tedious activity on the earth, work connected with mistakes and expenses, but as a result of familiarization with the knowledge stored in the "libraries" of other worlds.

Of course, this is a dream. It does not mean at all that we must turn from work and wait for that moment when we will be able to obtain the knowledge completely "gratis". The expensive approach is foreign to Soviet man. In the infinite variety of scientific ways many of the solutions can seem to be more original or more effective and are the investment which mankind will pay in the general affair, just as

soon as it is included in communication between civilizations of the galaxy.

Has the earth been visited by strangers from other worlds?

The achievements of rocketry, the multiplicity of populated worlds, in which practically no one now doubts, created the known credulity in respect to the possibility of interstellar flights. Several authors utilized this credulity. They did not consider with probability the realization of such flights, escaped the critical approach to the facts, on which hypotheses can be constructed concerning a visit of the earth in distant times or even now by strangers from other planets or even from other stars. These people obstinately sought a confirmation to such an hypothesis in legends, among them biblical ones, in unverified or simply unexplained facts and even in fraudulent fabrications.

This is the "evidence". Both the description of "observations of flying saucers" borrowed from foreign "literature", and giant plates in the Lebanese Desert which supposedly could not have been made by anyone besides astronauts, and biblical legends.

If we stick to this point of view, then it is easy to confirm that both the Koshka and Ayu-Dag Mountains in the Crimean were cut by visitors from other worlds. Tales about flying carpets etc. were supposedly composed by those who saw cosmic travelers, and any unexplained phenomenom is also only connected with this. One can further confirm that the very existance of life on the earth and the development of culture is the result of such a visit, and somewhere the difference between the religious representations and such "scientific hypotheses" will disappear.

Therefore, we must be very careful in studying the possible solar system visits in ancient times by strangers from other worlds.

In any case, there is now no irrefutable proof that this took place at sometime. In the best case, there can be natural phenomena or facts which cannot be explained at this time.

<u>The eternity of life</u>. The earth, as well as the whole solar system, originated

approximately five million years ago. Certain experimental data, in particular the displacement of spectral lines in the emissions of other galaxies, indicate that the separate galaxies of the Universe start "running" in various directions with a speed greater than the more distant of these galaxies. This provides a basis to assume that the part of the Universe we know originated possibly as a result of a giant explosion and, consequently, aged. Everything that has a beginning also has an ending, but not in the form of interference of external supernatural forces, and in the form of a specific change in phases of the development of material in the infinite cycle of this development. Man does not know the ulterior mode of the general development of the solar system, the development of the universe. Since it would not be offensive for man, one should note than sooner or later the sun will change its emission so much than its energy will not be sufficient for maintaining life on the earth. Of course, mankind of the future will have many possibilities to artificially prolong for colossal periods the existence of his world by means of regular conversion of the planets or even the entire solar system. Therefore, the cessasion of life in the system bears a principally faster possible than realistic character.

Life has already repeatedly refuted the mystical predictions of individual "prophets" concerning the near end of mankind as a result of overpopuletion, thermal death, degeneration or the "suicide of mankind".

The growing productive possibilities of man and the colossal reserves of obtaining products for nutrition disproved the Malthusian Theory.

The second law of thermodynamics, stating that heat exchange is possible only from more heated bodies to colder ones, was interpreted by certain foreign scientists as the "thermodynamic proff of the existance of God". It was considered that sooner or later the temperatures of all bodies will be equal and a state of equilibrium will occur, designated as "thermal death". Many proposed that "thermal death" will occur earlier for mankind, when the sources of petroleum and coal are depleted. Calculations indicated that this period will be computed in tens of years. Time

expired and the presence of the fuel reserves were not only the same but even were increased: new deposits were discovered. Moreover, mankind received practically unlimited supplies of nuclear energy. The perspective of using the internal heat of the earth and more complete utilization of solar energy is becoming real. The "thermal death" was pushed aside to an undetermined, very far distance.

But will this be, however? For the present, man does not have conclusive proof of the existance of the processes compensating the observable constant dissipation of energy, but, undoubtedly, it must be. Matter is continuously being developed according to its internal laws. The universe is not a time mechanism which is wound up by someone's hand from time to time.

A detailed development of the theory of relativity and further study of micro- and mega-worlds, undoubtedly, will provide the information concerning the links which the cyclic chain of energetic transformations of matter is fastened with.

In spite of the known limitedness of the possibilities of the existance of life in time and space, life is eternal, due to the eternal existance of matter.

CONCLUSION

The conclusion concerning the eternity of the existance of life denotes the unlimited possibilities for the development of human society, its culture, science and dominance over the forces of nature.

But this conclusion does not at all denote that it can rest on its laurels. Life teaches that everyting new, appearing as a result of regular development, does not influence the arena of history without the furious resistance of obsolescent forms of social development.

In a Declaration of the Soviet Government dated 31 August 1961, it says that "the Soviet Government could not fulfill its sacred duty to the peoples of its country, to the peoples of socialist countries, and to all nations striving towards a peaceful life, if it is faced with threats and military arrangements embraced by

the USA and some other NATO countries, it could not utilize the possibilities it has for the development of the most effective types of weapons capable of cooling the hot heads in certain capitols held by NATO.

In the Soviet Union projects were developed for the creation of a series of high power nuclear bombs (20-30-50 and 100 million tons of trotyl), and powerful rockets similar to the ones in which Major Yu. A. Gagarin and Major G. S. Titov made their unprecedented space flights around the earth, capable of lifting and delivering such nuclear bombs to any point of the globe where an attack might be made on the Soviet Union or other socialist countries. It would be inexcusable thoughtlessness not to make the corresponding conclusions from the circumstances which occured in view of the agressive politics of the NATO military block, and not to provide for the reinforcement of the safety and power of the Soviet State, the great socialist camp, and all peace-loving nations.

...In order to ward off the agressor's desire for criminal play with fire, it is necessary so that he will know and see that in the world there is a force armed and ready with universal weapons to repel any inclination towards the independence and safety of peace-loving nations, and that relaliatory weapons will overtake the agressor in his own den.

...Let everyone, to whom the preservation of peace is dear, know that they can bravely rely on the Soviet Union and on the titanic forces it can undertake to bring the leaders of the military psychosis to reason and to stop the accelerating course to a new war.

Invariably, guided by Lenin's principles of peaceful coexistance, the Soviet Union threatens no one and furthermore, does not intend to attack anyone. The Soviet Government triumphantly declares that the Armed Forces of the USSR will never be the first to have recourse to use their weapons?.

If the imperialists provoke a war, then it will be the last war for them. The nations will rise and destroy the capitalist order which breeds imperialistic wars.

Such wars in our era can lead if not to the threat to the very existance of mankind, then, at least, to an essential deterioration of the rising processes of development, to the senseless deaths of many millions of people and to the destruction of material values.

Mankind's entry into space has a special significance. The colossal armament race, being developed by the American imperialists and embracing the planet, overwhelms outer space.

The danger of the militarization of space by USA imperialists is great. It is aggravated by the fact that the smallest defect in armament, an error of the operator in the announcement service can lead to the wear and tear of the starting mechanism of a new war. Let us imagine the moment that a natural catastrophe happened, similar to the explosion of the Tunguss Meteorite. There is now no clear representation of its causes and for more than half a century after this incident. How can a clear representation be composed concerning the causes of a second such event, if it occurs during those several seconds which the people will have at their disposal, in order to receive the decision to deliver an "open" attack?

The exclusion of wars from world life is an urgent necessity because modern technical means are capable not only of causing the most severe destruction in case of war, but in the intelligence of their use they can give men exclusive possibilities for raising his welfare and expanding his production.

In investigations and exploitations of natural riches is the real and solitary possibility of the blossoming of economics, and rockets and space ships can and must play an honored role in this affair.

The possible perspectives of scientific and economic utilization of satellites were noted above. Some of them promise a definite economic gain. Others do not offer possibilities of seeing a gain immediately, but present much interest from an investigative point of view.

One should note that the perspectivity of planetary investigations and the study

of the atmospheric processes with the aid of satellites is also acknowledged by foreign scientists. But the specific purpose of the investigations in the capitalistic countries differs from ours.

Characteristic in this respect are the commentaries of an American scientist, E. Teller (one of the creators of the American hydrogen bomb) on the launching by the Soviet Union of the first artificial satellite in the world. Regarding the high development of Soviet science, he remarked that if the Russians learn to control the atmospheric processes before the Americans, then it will permit them to conquest the USA without war. And here is another characteristic of the actuality of learning the mechanism of the atmospheric processes. The American scientist, R. Oppenheimer, (a specialist in atomic nuclear physics, and director of the American project for the creation of the atomic bomb) greeted a symposium in 1955 in the USA, devoted to the problem of utilizing computer engineering for the study of the dynamics of the climatic processes. Oppenheimer compares the symposium with a meeting in Los Alamos during the war, at which the project for creating the atom bomb was discussed, but remarks that at this time the problem is immeasurably more complicated.

Soviet scientists, in differing from many Americans, avoid the striving to devise some equivalent of nuclear weapons from geophysics. For Soviet scientists geophysics, and also astrophysics is above all the possibility of the ulterior rapid development of productive forces, and the further raising of the welfare of the nation constructed by communism.

Does this mean that only those fields of science must be developed which offer an obvious and rapid economic effect? Of course not.

Economic utilization follows a detailed comprehension of that or any discovery, any result obtained in the process of long scientific research. And very often it is impossible to foresee all possible consequences of any newly discovered phenomenom. It is known that a German scientist, G. Hertz, who discovered radio waves, proposed that they will not have any practical significance. A few years were needed

so that the works of the Russian scientist, A. S. Popov, indicated that the utilization of radio waves will find wide application, and right now it is impossible to imagine our science and engineering without radio apparatus, and the world without radio communications and television.

Another example should be indicated. A British scientist, Rezerford, who split an atomic nucleus, also proposed that this achievement will have only a theoretical significance. This proposal also turned out to be erroneous. The energy of an atomic nucleus was soon utilized for the creation of a destructive weapon, and now it is being widely applied in the national economy. The atomic icebreaker "lenin" breaks polar ice, and for a long time already atomic electrostations have been providing current. Many similar examples can be given.

It is doubtless that those planetary investigations which will be made with automatic rockets, satellites and man himself, leaving the limits of the earth and even reaching other planets, will create practical possibilities which are now difficult to foresee. Obviously, the specific trends of the various directions of investigation, already known now and possible in the future, consist in the powerful flow of knowledge by Soviet men of the universe, which will be widely used in practical activity.

Overcoming the force of gravity of the planet is a large victory of the human intellect. It is a pledge of the affirmation of the power of man over the forces of nature.

The age of interplanetary voyages has started. Man is penetrating space. The task of the scientists is to provide the astronauts with data concerning what takes place in space in order to accurately guide the ships flying in the depths of the Universe.

The future of Soviet man is beautiful. In it, the knowledge of nature is organically being interwoven, with the mastery of space, the development of economics and the building of communist society.

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